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AVIATION CAPACITY ENHANCEMENT PLAN

FEDERAL AVIATION ADMINISTRATION
OFFICE OF SYSTEM CAPACITY

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The FAA at Two Turning Points in Aviation History

1999 – The Air Traffic Control System Command Center in Herndon, Virginia.
Through the continuous monitoring of traffic and weather in the National Airspace System and collaboration with industry, the Command Center is leading the FAA into the era of air traffic management.

1955 – Washington Air Route Traffic Control Center in Washington, D.C.
Air traffic controllers tracking airplanes on a radarscope.
As pictured from left to right:

Lyle Neher (seated), Malcolm Champagne, John Allen, Hedrick Wolford, Jerry Titherington, Walter Faison and Leslie O. Cox (seated)

PREFACE

The Aviation Capacity Enhancement (ACE) Plan is published annually by the Federal Aviation Administration's (FAA) Office of System Capacity (ASC). The ACE Plan is a reference guide to new and on-going FAA initiatives to expand airport and airspace capacity.

The FAA's goal is to expand the capacity of the National Airspace System (NAS) so that it is ready to meet projected increases in demand. This is a complex goal that requires a systematic approach, involving all elements of the FAA and the active participation of the entire aviation community. Included in these efforts are airport development, terminal and en route airspace improvements, enhanced air traffic control procedures, improved weather detection and dissemination, and the application of new technologies.

Many of the capacity initiatives described in the ACE Plan will take several years to develop and implement, but each is an important step towards meeting future demand. The ACE Plan is organized into seven chapters:

- Chapter 1 outlines the transition of the air traffic control system from a philosophy of positive control to one of air traffic management, with a special emphasis on the programs at the Air Traffic Control System Command Center.
- Chapter 2 describes current and projected activity and demand in the National Airspace System.
- Chapter 3 discusses FAA's measures of system capacity and performance: delay, flexibility, predictability, and access.
- Chapter 4 summarizes the FAA's efforts towards National Airspace System Modernization.
- Chapter 5 describes airport development projects at airports throughout the National Airspace System.
- Chapter 6 discusses efforts to enhance capacity by redesigning airspace to permit its more efficient use without compromising safety, and
- Chapter 7 describes the development and implementation of new operational procedures that can increase capacity with little investment in airport infrastructure or equipment.

Additional information on aviation activity and construction projects at the 100 busiest airports (measured in terms of passenger enplanements) are presented in a series of appendices following the body of the ACE Plan:

- Appendix A contains five tables that provide historical, current and forecast information about aircraft operations and passenger enplanements at the 100 busiest U.S. airports.
- Appendix B summarizes the status of recommendations of completed Capacity Enhancement Plans at airports throughout the country.
- Appendix C presents airport layouts for the 100 busiest U.S. airports, highlighting current capacity enhancement projects.
- Appendix D defines acronyms used in the ACE Plan, and
- Appendix E lists references used to prepare the ACE Plan and credits for materials from FAA and non-FAA sources.

EXECUTIVE SUMMARY

Executive Summary

On the brink of the second century of aviation, the 1999 Airport Capacity Enhancement (ACE) Plan's theme is the continuing shift in the Federal Aviation Administration's (FAA) philosophy from the traditional concept of air traffic control, in which pilots are directed by controllers, to the new idea of air traffic management where decisions are made collaboratively between dispatchers and air traffic managers.

This shift will be made possible by the development of new technologies but it will be accomplished only through the willingness of all parties to work together towards a common goal. The Air Traffic Control System Command Center's Collaborative Decision Making Program, which is an excellent example of the effective use of technological improvements through a cooperative relationship, is highlighted in this year's ACE Plan.

The overall ACE Plan describes the current status of the National Airspace System (NAS) and outlines FAA initiatives to expand airport and airspace capacity.

Continued Growth in National Airspace System Activity Expected

In 1998, approximately 643 million commercial passengers flew in the system (enplanements), while all users conducted 65.3 million aircraft operations (take-offs and landings). Activity at the 100 busiest passenger airports (ranked by enplanements) accounted for more than 95 percent of enplanements and 42 percent of operations, demonstrating the continued concentration of commercial traffic at larger airports. The FAA forecasts that over the next ten years activity will continue to grow steadily, with enplanements reaching 991 million and operations 81.2 million in 2010, continuing to place pressure on both airport and airspace capacity.

Capacity Performance Measures: Delay, Flexibility, Predictability, and Access

Delay is the traditional measure of the performance of the NAS, but the FAA has added other measures of performance in order to better describe the experience of NAS users. The flexibility of the air traffic control system as it provides services to users is important from both an operational and economic perspective. Predictability, a measure of the variability of the provision of those air traffic services, is important to users' effective flight planning. Finally, users' access to airports, airspace, and air traffic services is a fundamental component of any aviation activity.

Approximately 306,000 flights were delayed 15 minutes or more in 1998, an increase of nearly 25 percent from 1997. Delays due to weather represented 74 percent of total delays. The ACE Plan describes the FAA's efforts to develop automated weather information systems to provide pilots and controllers with better information about upcoming weather. The FAA is also working to reduce other causes of delays.

The FAA is also undertaking projects to increase the flexibility and predictability of the air traffic control system and to increase access for all NAS users. Among the initiatives underway to address these concerns are: increasing flexibility by reducing the number of ATC-preferred routes and the development of area navigation routes and procedures; increasing predictability by improving communication between controllers and users; and increasing access by developing an augmented GPS system and developing new systems to provide information on the availability of military special use airspace to civilian users.

Airport Capacity Initiatives

Airport development is the key to the expansion of airport capacity and to the efficient use of existing airports. The largest three airports, in terms of aircraft operations, are Dallas-Fort Worth (DFW), Chicago O'Hare (ORD), and Hartsfield Atlanta International (ATL) airports. Delays at each of these airports exceed five minutes of delay per operation. ASC is currently a participant in airport development projects at DFW and ATL and in a major program of airspace improvements in the Chicago metropolitan area, which includes ORD and other airports.

A number of airport development projects at other airports have been completed or are now underway. Twenty-five runway projects at the 100 busiest airports have been completed over the last four years. Over ninety runway projects are planned, proposed, or currently under construction (including 42 new runways and 49 runway extensions).

Airspace Capacity Initiatives

Airspace redesign and new operational procedures are vital to the efficient use of airborne capacity. Because air transportation is a dynamic industry, the FAA adjusts airspace structure and procedures to meet changing traffic demands.

The recent implementation of a new arrival enhancement procedure (AEP) at Los Angeles International Airport (LAX), which was cited as the Air Traffic Control "Accomplishment of the Year," is an example of how technological, organizational and procedural changes work together to further FAA's goals. Other airspace studies are underway, including the National Airspace Redesign, the West Coast Airspace Analysis, and deployment of area navigation routes in several areas.

New operational procedures are being developed for en route, oceanic and terminal/approach environments. These include, respectively, the North American Route Program and the Three-Dimension User-Preferred Trajectories Flight Trials; Reduced Vertical and Horizontal Separation Minima programs in North Atlantic and Northern Pacific airspace; and, new area navigation departure procedures at LAX, the removal of the 250-knot speed limit for departures from Houston Class B airspace, and simultaneous offset instrument approaches at airports with closely spaced parallel runways, such as San Francisco International Airport.

NAS Modernization

NAS Modernization continued in 1999, advancing multi-year projects to enhance capacity by developing and installing new equipment. These projects are broadly categorized in three functional areas: communications, navigation and surveillance systems; weather detection and reporting systems; and, air traffic decision support systems. Because modernizing the NAS has inherent risks, the FAA has developed two strategies, Free Flight Phase 1 and Safe Flight 21, to reduce technical and financial risks through the limited implementation of selected technologies for evaluation prior to their full implementation.

Other Important Developments

The rapid growth of the use of regional jets, the result of the changeover of the commuter/regional airline fleet from propeller-driven aircraft, is changing the distribution of traffic in the NAS. Because regional jets can fly at higher altitudes, the number of aircraft using high altitude airspace may increase more rapidly than traffic as a whole. The FAA will have to adjust air traffic control sectors if demand for airspace shifts from low altitude to high altitude sectors.

The rapid increase of commercial space launches will provide new challenges to the FAA. In the past, commercial space launches have had little impact of the NAS because of the infrequency of their occurrence and because most launches have occurred within restricted military airspace. But now, new inland launch sites are being evaluated and reusable launch vehicles, which may take off, re-enter under power, and land on conventional runways, are being considered. Accommodating these new users will require development of appropriate procedures and the imposition of restrictions on other NAS users.

The ACE Plan summarizes the FAA's responses to the continuing challenges of aviation in this century and its plans to accommodate continued growth in the next century.

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CHAPTER 1: THE TRANSITION TO AIR TRAFFIC MANAGEMENT

1 THE TRANSITION TO AIR TRAFFIC MANAGEMENT

The ACE Plan is a forward-looking document that describes the FAA's initiatives to expand airport and airspace capacity. But this year, on the brink of the second century of aviation, we are also taking a brief look back. The cover of the 1999 ACE Plan shows an air route traffic control center (ARTCC) from the mid 1950's and today's Air Traffic Control System Command Center (ATCSCC). These facilities represent the FAA at two turning points in aviation history.

1.1 Introduction

In 1959, more than 50 million passengers flew between the major cities of the continental United States. They flew in DC-7s and Lockheed Constellations, at about 325 miles per hour at 23,000 feet. Flying from New York to Los Angeles took almost eight hours. But the aviation system was on the cusp of enormous change. In the previous year, two momentous events had taken place.

First, the Congress passed the Federal Aviation Act, which created the Federal Aviation Authority (the FAA was renamed the Federal Aviation Administration when the Department of Transportation was created in 1967). Congress gave the new authority sole responsibility for a common civil-military system of air navigation and air traffic control. And on December 10, 1958, National Airlines inaugurated domestic jet service on its New York-Miami route. Shortly thereafter, American Airlines became the first airline to provide transcontinental jet service, setting a new time record of four hours and 47 minutes from New York to Los Angeles. Almost overnight, B-707s and DC-8s replaced fleets of DC-7s and Constellations. Jet aircraft would revolutionize air travel and the FAA's air traffic control system.

The changes continued in 1959. The Civil Aviation Authority had established positive control over all continental airspace above 24,000 feet in 1957 (later expanded to all airspace between 18,000 and 60,000 feet). Under positive control, pilots are required to file flight plans, fly along designated airways and under Instrument Flight Rules regardless of weather conditions. But using estimates of aircraft positions required separation distances that used too much airspace for the system to handle the steadily increasing volume of traffic. Radar made positive control practical by enabling controllers to reduce separation distances between aircraft, since the separations were based on actual distances, not estimates. But positive control still required extensive voice communications between pilot and controller for position reports of specific aircraft. Not until second generation radar could identify the location of a specific aircraft was the modern system born.[1] The first second generation radar was installed in September 1959, just as jet aircraft were being introduced. Primary and secondary radar and positive control are still at the heart of today's air traffic control system.

In the past year, well over 600 million passengers flew in the United States. Today's quieter jets fly at 650 miles per hour and at 40,000 feet. Yet today, as in 1959, the aviation environment is about to change, again as the result of new technology. The Global Positioning System (GPS), already commonly used in oceanic and en route airspace, when augmented by ground stations will provide approach and landing navigation and guidance, largely replacing the existing ground-based navigation system.

1 Second generation radar combines primary radar, which provides surveillance of all aircraft in an area, with secondary radar, which, in conjunction with a transponder, identifies specific aircraft.

Two major developments in GPS navigation took place in 1999. First, the Johns Hopkins Applied Physics Laboratory released a long-awaited study on the use of GPS as the sole means of navigation, that is, with no backup systems. This will, once ratified by the FAA, permit the decommissioning of most of the current ground-based navaids. The second development was the announcement of an agreement to add additional signals to the next series of GPS satellites, to be launched in 2003 and 2007. Using these additional signals will increase the availability and integrity of the basic GPS signals. Both of these developments, along with the FAA's continuing work on the Wide Area Augmentation System and the Local Area Augmentation System, move the everyday use of GPS navigation ever closer.

Equally important as the coming of GPS is that the philosophy of positive control, in which pilots are directed by controllers, is moving to the new idea of air traffic management, where decisions are made collaboratively between dispatchers and air traffic managers.

At this turning point, the Command Center is leading the FAA into the era of air traffic management. The Command Center's key traffic management program, Collaborative Decision Making (CDM), is a blend of technology and the new philosophy of air traffic management. The technology facilitates the cooperation, but it is the willingness of all parties to work together that makes a new system possible. The history of the Command Center itself gives a preview of how a collaborative system can work. The FAA first had to develop a system for its centers (ARTCCs) to work together to maximize system efficiency.

1.2 From Flow Control to Collaborative Decision Making

The Command Center was established in 1970 to integrate the functions of several air traffic control programs. But it was one of those programs, central flow control, which marked the first change in the philosophy of air traffic control that would eventually lead to CDM. Later in 1970, the FAA established the Central Flow Control Facility (CFC) with a new mandate: to monitor air traffic demand in the air traffic control system as a whole and suggest solutions to optimize traffic movement throughout the system.

The new facility's operation was based on flow control, the restriction of the movement of aircraft from the control of one center to another (such as increasing separation distances between aircraft and keeping planes on the ground until they could fly to their destination without en route delay). Flow control had long been used by the individual centers to control traffic within their own airspace—but central flow control would extend that to multi-center monitoring and restrictions.

Central flow control was a response to the inefficiencies of an air traffic system with 21 centers, in which no one center had enough information about weather and traffic to make judgments based on the overall condition of the air traffic system. This resulted, far too often, in isolated instances of congestion spreading to disrupt the flow of aircraft throughout the system. When the sole responsibility for flow control was in the individual centers, each center made decisions from the limited perspective of its own control area. The individual centers tended to be defensive and to impose more restrictions on air traffic than were warranted by actual circumstances. When a buildup in traffic forced one center to restrict the number of incoming aircraft from an adjacent center, that center, fearing an impending traffic buildup in its own area, would institute restrictions against yet another center. With each center in turn acting defensively, the restrictions could quickly spread throughout the system.

Central flow control short-circuited this process by providing the key ingredient that was missing: contemporaneous information about traffic, capacity, and weather in the entire system. Linked to all 21 centers, the facility identified potential trouble spots and suggested solutions, such as flow control or aircraft rerouting, to the centers. At that time, the individual centers retained the authority to issue flow restrictions, but their decisions were now more likely to be based on a true picture of the overall air traffic system.

The central flow control system worked well from the beginning and played a vital role in maintaining the safety of the air traffic control system in the aftermath of the controllers strike in 1981. It provided direct benefits to industry through more efficient routings, improved service to air travelers by eliminating air traffic bottlenecks, and assisted the FAA in managing the air traffic control system by safely balancing air traffic demand with system capacity.

Since the Central Flow Control Facility was established, its monitoring and analysis systems have been continuously improved. In 1977 and again in 1983, its computer hardware was upgraded to handle increasing air traffic. In 1987, CFC began using the Aircraft Situation Display (ASD), which provided traffic managers with a near real-time visual display of en route aircraft, nationally, regionally, or to a specific airport terminal area. The next year, ASD was augmented with Monitor Alert, which analyzed flight plans and projected when and where airspace congestion might occur. The Enhanced Traffic Management System, which could predict nationwide air traffic demand, enabling traffic managers to take corrective action, was installed in 1990.

But the CFC monitored weather as well as traffic, so weather systems have also been improved. In 1992, Meteorologist Weather Processors were installed at the 21 en route centers and the central flow control facility, providing controllers with weather data from the National Weather Service, FAA radars and a privately-operated satellite. More recently, the FAA announced plans to develop the Weather and Radar Processor, a more advanced weather data processing system.

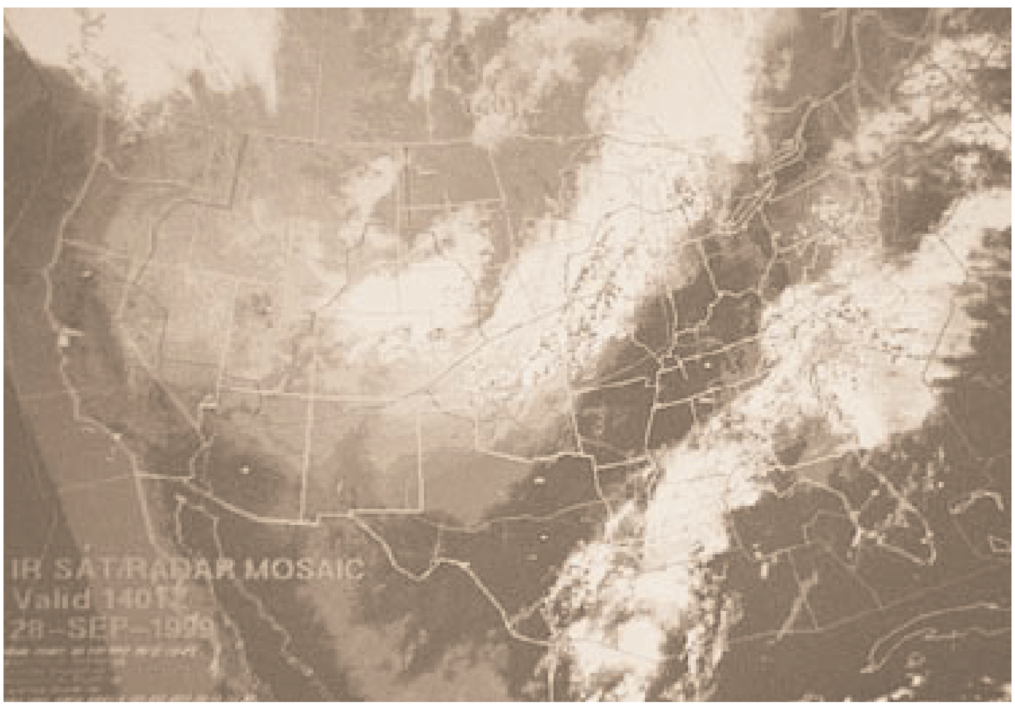
Finally, the CFC, along with the rest of the Command Center, was relocated from its cramped, outdated facility at FAA's Washington Headquarters to a new state-of-the-art air traffic management center building at Herndon, Virginia. Eleven large screen projection systems provide controllers with a near real-time picture of air traffic and weather throughout the National Airspace System (NAS). In an innovative strategy, the FAA is leasing the building, equipment and computer services, enabling it to adopt new technologies without making new purchases.

But most importantly, the idea of central flow control works. The technological advancements in monitoring traffic and weather have helped, but its success has been based on the willingness of the centers and the CFC to work together. Over the years, they have learned how to work collaboratively, towards a common goal of minimizing congestion while maximizing the overall use of the system. Now the FAA is using the same philosophy to work with NAS users.

1.3 Collaborative Decision Making and Ground Delay Programs

Collaborative Decision Making is a joint FAA/industry initiative to improve traffic flow by sharing information on airport demand and capacity and cooperating in shared decision making. CDM's key feature is the CDMNet, an intranet that permits the exchange of real-time information between NAS users and FAA facilities. CDMNet serves as the communications link between airline operational control centers (AOCs) and the Command Center. The AOCs send schedule updates over the CDMNet to the Volpe National Transportation Center. Volpe consolidates the updates with other NAS information and sends out an aggregate demand list (ADL) to the Command Center and the AOCs. ADLs are sent out every five minutes, providing an accurate picture of actual demand.

Both airlines and the Command Center use a software package called Flight Schedule Monitor (FSM) to view the ADLs. FSM displays arrival demand, airport acceptance rates, specific flight information and other pertinent NAS information. With this common situational awareness, NAS users are able to understand, and participate in, the Command Center's traffic management decisions.



The Command Center continuously monitors the NAS for situations where arrival demand may exceed airport capacity and implements Ground Delay Programs (GDPs) to deal with the imbalances. A GDP delays an aircraft on the ground at its airport of origin and assigns specific delayed departure times to all aircraft bound for a congested airport, so that arrival demand does not exceed arrival capacity. Airport arrival capacity may be reduced because of weather, a runway closure, equipment outages, or for other reasons. Weather remains the primary cause of GDPs. When assessing the need for a weather-related GDP, the Command Center consults with at least two AOCs as well as with the FAA facilities in the region. When a consensus forecast is reached and reduced arrival acceptance rates determined, a specialist sends out a CDM advisory to all participants, enough in advance of the actual GDP that they have enough time to reduce demand by canceling or delaying flights, possibly avoiding the GDP altogether. New ADLs reflect the cancellations and other schedule changes.

The Command Center's primary goals during a GDP are to allocate available slots in a fair and equitable manner, to ensure that all allocated slots are used, and to allow NAS users to decide which specific flights use each slot. CDM uses a system called distributed planning to accomplish these goals. When arrival capacity is reduced, the limited arrival times must be rationed. FSM uses an allocation scheme called Ration by Schedule, which assigns each flight a controlled time of arrival (or slot). Each flight, including those that have been cancelled or delayed, is assigned a slot based on its original time of arrival (this is to ensure that airlines are not penalized for providing current information). FSM uses programs called substitution and compression to ensure that all slots are used. The Command Center is concerned only with the overall demand/capacity balance, but airlines consider some flights more important than others, for a variety of economic and operational reasons. Substitution permits an airline to move a selected flight into a slot that is open because the flight to which that slot had been assigned has been cancelled or delayed.

Sometimes, however, an airline will own a slot that it cannot use. Compression, or bridging substitutions, allows an airline with a later slot to move a flight into the open slot. The slot opened up by the moved flight is offered back to the original airline for its use, and then to other airlines if it cannot be used by the original airline. The compression algorithm gives priority to the owner of the slot until it assigns a flight to another open slot. The compression process cascades through the flight schedule, benefiting all airlines and reduces overall GDP delays.

FSM provides the technology that facilitates the iterative process that makes it possible in real time, but it is the cooperation of the airlines that is the key to a successful outcome. NAS users provide input into traffic management decisions to ensure that limited resources are used in a manner that accommodates individual business needs. All CDM participants have the flexibility to make their own operational decisions. Substitution and compression allow each airline to use the slots allocated to it in a manner that best meets its individual business needs. If conditions change, the specialist can change the parameters of the GDP and a new list of controlled times is issued. The users are again given the opportunity to make cancellations and substitutions before the next compression. In less than 20 minutes; the revised GDP is in full operation. The Command Center monitors the GDP through completion or until it can be cancelled because of improving conditions.

CDM was initially tested at San Francisco International Airport, beginning in January 1998. Delays during ground delay programs were reduced by 15 percent during the experimental period. CDM was extended to all U.S. airports in September 1998 and is fully operational today.

CHAPTER 2:
NATIONAL AIRSPACE SYSTEM ACTIVITY AND DEMAND

2 National Airspace System Activity and Demand

Traffic in the NAS is growing steadily. This increasing demand is placed on an aviation system where key airports are already frequently congested. Aviation in the United States includes a number of diverse participants: passenger airlines, commuter/regional air carriers, cargo airlines, the military, and general aviation operators. In 1998, there were 86 U.S. commercial airlines, of which 62 were passenger airlines and 24 were all-cargo carriers. By 2010, the number of air carrier jet aircraft is expected to increase by almost 60 percent, to 8,360. This chapter provides information on current and projected aviation activity, and the different segments of the aviation community.

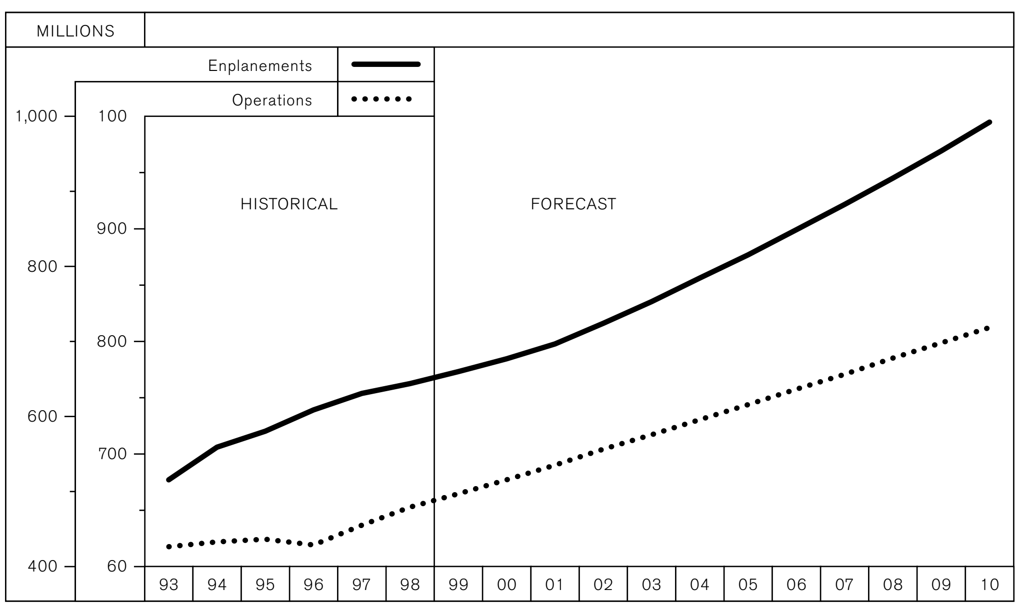
Aircraft operations, passenger enplanements, air cargo tonnage, and the number of active aircraft are all indicators of aviation activity and demand for FAA services. This section describes trends in these indicators.

2.1 U.S. Aircraft Operations and Passenger Enplanements

Over the past five years, the number of passenger enplanements has grown faster than aircraft operations, primarily due to increasing load factors. From 1993 to 1996 the number of aircraft operations in the U.S. remained stable at approximately 62 million, then increased to an estimated 65.3 million in 1998, a 5.3 percent increase over the five-year period. Air carrier and regional/commuter enplanements on the other hand, increased steadily from 516 million in 1993 to an estimated 643 million in 1998, a 25 percent increase.

The FAA forecasts aircraft operations to increase to 81.2 million by 2010, an increase of 24 percent, and for enplanements to increase to 991 million, an increase of 54 percent.[2] The continued higher growth predicted for passenger enplanements is primarily due to a projected increase in seating capacity for air carrier aircraft. Figure 2-1 illustrates the trend in aircraft operations and passenger enplanements nationwide.

Figure 2-1: Trends in Operations and Enplanements, FY 1993-2010



2 U.S. Department of Transportation. *FAA Aerospace Forecasts Fiscal Years 1999–2010*, March 1999. Table 11 - U.S. Commercial Air Carriers and Regionals/Commuters, Total Scheduled U.S. Passenger Traffic.

2.1.1 Operations and Enplanements at the 100 Busiest Airports

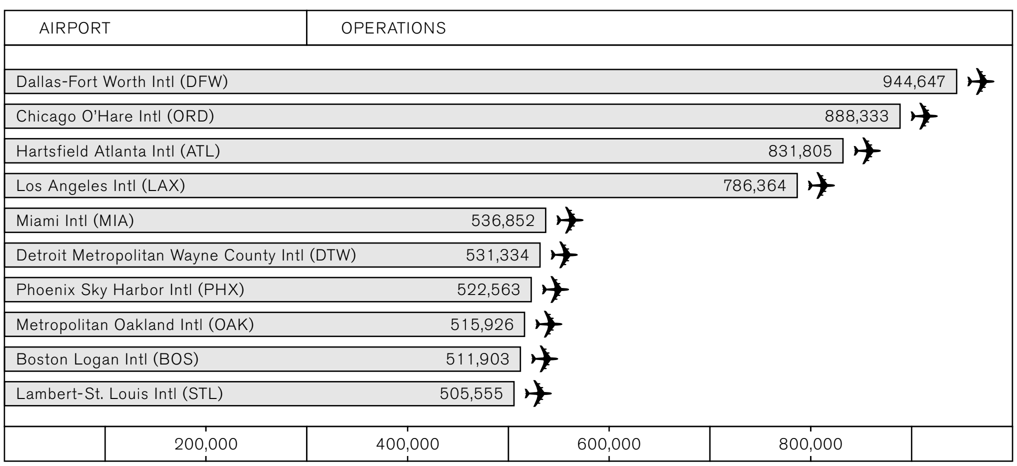
Operations and enplanements for the 100 busiest airports in the U.S., as measured by 1998 passenger enplanements, are shown in Appendix A. Because of the concentration of commercial traffic at larger airports and the dispersion of general aviation (GA) traffic across a wide range of airports, these 100 airports accounted for more than 95 percent of passenger enplanements in 1998, but only 42 percent of operations.

The number of operations at the 100 busiest airports increased from 25.4 million in 1993 to 27.4 million in 1998, a 6.7 percent increase over the five-year period. Over the same period, the number of enplanements increased from 480 million to 610 million, a 27 percent increase. However, over the last year the increasing traffic trends at the 100 busiest airports have slowed. From 1997 to 1998, the number of operations at the 100 busiest airports increased less than one percent, while the number of enplanements increased 2.6 percent. By 2013, operations at the 100 busiest airports are projected to increase to 37.5 million and enplanements to 1 billion.[3]

2.1.2 Busiest and Most Rapidly Growing Airports

The most rapidly growing airports are those where capacity constraints will most likely have an impact in the near future. Figures 2-2 and 2-3 show the 10 airports with the most operations and enplanements, respectively, in 1998.

Figure 2-2: Ten Busiest U.S. Airports, by Operations, FY 1998



3 FAA Office of Aviation Policy and Plans, Statistics and Forecast Branch (APO-110).

Figure 2-3: Ten Busiest U.S. Airports, by Enplanements, FY 1998

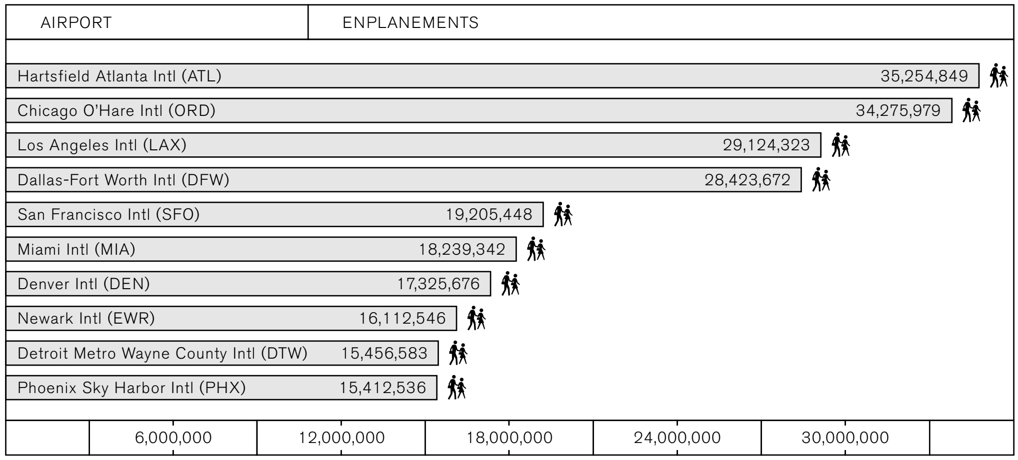


Figure 2-4 lists the 10 airports with the greatest projected increase in the percentage of operations between 1998 and 2013. Only three of these airports are considered large-hub commercial service airports today (airports with more than one percent of all enplanements).

Figure 2-4: Ten Fastest Growing U.S. Airports, by Percentage Increase in Operations, FY 1998-2013

			Operations (Fiscal Year)		
Airport	**ID**	**98 Rank***	**1998**	**2013**	**% Change**
Southwest Florida Regional	RSW	99	67,291	133,181	97.9%
Ontario Intl	ONT	81	142,226	249,662	75.5%
City of Colorado Springs Municipal	COS	63	173,273	301,767	74.2%
Orlando Intl	MCO	27	363,285	624,350	71.9%
Sacramento Metropolitan	SMF	72	152,860	258,860	69.3%
Manchester	MHT	94	100,617	169,294	68.3%
Houston Intercontinental	IAH	18	440,038	739,100	68.0%
McCarran Intl	LAS	14	461,949	771,991	67.1%
Reno Cannon Intl	RNO	70	156,008	258,108	65.4%
Standiford Field	SDF	64	172,100	278,581	61.9%

** Ranked by 1998 Fiscal Year Operations*

Note: Airports in bold are considered large-hub airports today.

Figures 2-5 and 2-6 show the 10 busiest airports in 2013, based on projected operations and enplanements, respectively. The four busiest airports in 1998 are expected to remain the busiest in 2013.[4] Figure 2-7 lists the 10 airports with the greatest projected increase in the number of operations from 1998 to 2013. All of these are large-hub airports, indicating that pressure on these already congested airports will continue to grow over the next 15 years.

4 The four busiest airports, in terms of projected operations and enplanements in FY 2013, are Dallas-Fort Worth, Hartsfield Atlanta, Los Angeles, and Chicago O'Hare.

Figure 2-5: Ten Busiest U.S. Airports, by Projected Operations, FY 2013

Airport	ID	98 Rank*	Operations (Fiscal Year) 1998	2013	% Change
Dallas-Fort Worth Intl	DFW	1	944,647	1,368,679	44.9%
Hartsfield Atlanta Intl	ATL	3	831,805	1,219,597	46.6%
Los Angeles Intl	LAX	4	786,364	1,145,784	45.7%
Chicago O'Hare Intl	ORD	2	888,333	1,101,597	24.0%
Phoenix Sky Harbor Intl	PHX	7	522,563	793,005	51.8%
Miami Intl	MIA	5	536,852	782,221	45.7%
McCarran Intl	LAS	14	461,949	771,991	67.1%
Detroit Metropolitan Wayne County Intl	DTW	6	531,334	760,805	43.2%
Houston Intercontinental	IAH	18	440,038	739,100	68.0%
Minneapolis-St. Paul Intl	MSP	12	481,220	724,119	50.5%

** Ranked by 1998 Fiscal Year Operations*

Figure 2-6: Ten Busiest U.S. Airports, by Projected Enplanements, FY 2013

Airport	ID	98 Rank*	Enplanements (Fiscal Year) 1998	2013	% Change
Hartsfield Atlanta Intl	ATL	1	35,254,849	58,950,098	67.2%
Chicago O'Hare Intl	ORD	2	34,275,979	51,614,148	50.6%
Los Angeles Intl	LAX	3	29,124,323	51,288,233	76.1%
Dallas-Fort Worth Intl	DFW	4	28,423,672	47,876,831	68.4%
Miami Intl	MIA	6	18,239,342	33,848,844	85.6%
San Francisco Intl	SFO	5	19,205,448	31,450,328	63.8%
Phoenix Sky Harbor Intl	PHX	10	15,412,536	30,236,510	96.2%
McCarran Intl	LAS	13	14,393,296	29,673,735	106.2%
Detroit Metropolitan Wayne County Intl	DTW	9	15,456,583	29,611,452	91.6%
Houston Intercontinental	IAH	15	14,126,938	28,488,204	101.7%

** Ranked by 1998 Fiscal Year Enplanements*

Figure 2-7: Ten Fastest Growing U.S. Airports, by Projected Increase in the Number of Operations, FY 1998-2013

Airport	ID	98 Rank*	Operations (Fiscal Year) 1998	2013	Increase in Ops
Dallas-Fort Worth Intl	DFW	1	944,647	1,368,679	424,032
Hartsfield Atlanta Intl	ATL	3	831,805	1,219,597	387,792
Los Angeles Intl	LAX	4	786,364	1,145,784	359,420
McCarran Intl	LAS	14	461,949	771,991	310,042
Houston Intercontinental	IAH	18	440,038	739,100	299,062
Phoenix Sky Harbor Intl	PHX	7	522,563	793,005	270,442
Orlando Intl	MCO	27	363,285	624,350	261,065
Cincinnati-Northern Kentucky Intl	CVG	19	437,716	695,347	257,631
Miami Intl	MIA	5	536,852	782,221	245,369
Minneapolis-St. Paul Intl	MSP	12	481,220	724,119	242,899

** Ranked by 1998 Fiscal Year Operations*

2.2 Air Cargo

Air cargo is transported in the baggage compartments of scheduled passenger aircraft and by all-cargo aircraft. In 1998, there were approximately 1,500 all-cargo jet aircraft worldwide. Boeing projects that the world jet freighter fleet will nearly double by 2018. Airbus predicts an even greater increase in the freighter fleet, to 3,400 by 2018. Both manufacturers predict that approximately 75 percent of the dedicated cargo fleet will be converted passenger planes.

Most all-cargo flights are scheduled during off-peak periods and do not substantially contribute to airport congestion and delay problems. Figure 2-8 lists the top 25 U.S. airports by tonnage of cargo loaded and unloaded for 1996, 1997, and 1998, and the percentage change in tonnage from 1997 to 1998. The tonnage shipped at these 25 airports increased three percent from 1997 to 1998. Indianapolis experienced the most growth, with a 23 percent increase from 1997 to 1998, due to the initiation of service by a large air cargo carrier and an apron expansion allowing another carrier to increase its air cargo operation.

Figure 2-8: Top 25 U.S. Airports by Total Cargo

			Thousands of Metric Tons*			% Change
City	**Airport**	**ID**	**1996**	**1997**	**1998**	**1997-1998**
Memphis, TN	Memphis Intl	MEM	1,934	2,233	2,369	6%
Los Angeles, CA	Los Angeles Intl	LAX	1,719	1,873	1,861	-1%
Miami, FL	Miami Intl	MIA	1,710	1,766	1,793	2%
New York, NY	John F. Kennedy Intl	JFK	1,636	1,668	1,604	-4%
Chicago, IL	Chicago O'Hare Intl	ORD	1,260	1,407	1,442	3%
Louisville, KY	Standiford Field	SDF	1,369	1,346	1,395	4%
Anchorage, AK	Anchorage Intl	ANC	1,269	1,260	1,289	2%
Newark, NJ	Newark Intl	EWR	958	1,043	1,094	5%
Atlanta, GA	Hartsfield Atlanta Intl	ATL	800	865	907	5%
Dayton, OH	Dayton Intl	DAY	767	813	893	10%
Indianapolis, IN	Indianapolis Intl	IND	609	663	813	23%
Dallas/Ft. Worth, TX	Dallas-Ft. Worth Intl	DFW	775	811	802	-1%
San Francisco, CA	San Francisco Intl	SFO	712	780	772	-1%
Oakland, CA	Metropolitan Oakland Intl	OAK	615	678	699	3%
Toledo, OH	Toledo Express	TOL	345	521	537	3%
Philadelphia, PA	Philadelphia Intl	PHL	494	486	512	5%
Denver, CO	Denver Intl	DEN	390	437	447	2%
Honolulu, HI	Honolulu Intl	HNL	436	501	444	-11%
Boston, MA	Boston Logan Intl	BOS	406	442	440	-0.4%
Seattle/Tacoma, WA	Seattle-Tacoma Intl	SEA	388	394	428	9%
Ontario, CA	Ontario Intl	ONT	396	419	412	-2%
Minneapolis/St. Paul, MN	Minneapolis-St. Paul Intl	MSP	361	379	365	-4%
Cincinnati, OH	Greater Cincinnati Intl	CVG	289	363	364	1%
Washington, DC	Washington Dulles Intl	IAD	309	350	354	1%
Houston, TX	George Bush Intercontinental	IAH	310	328	355	8%
Total			**20,257**	**21,826**	**22,394**	**3%**

** Loaded and unloaded freight and mail in thousands of metric tons.*

Source: Airports Council International (ACI) Traffic Data: World Airports Ranking by Total Cargo 1998

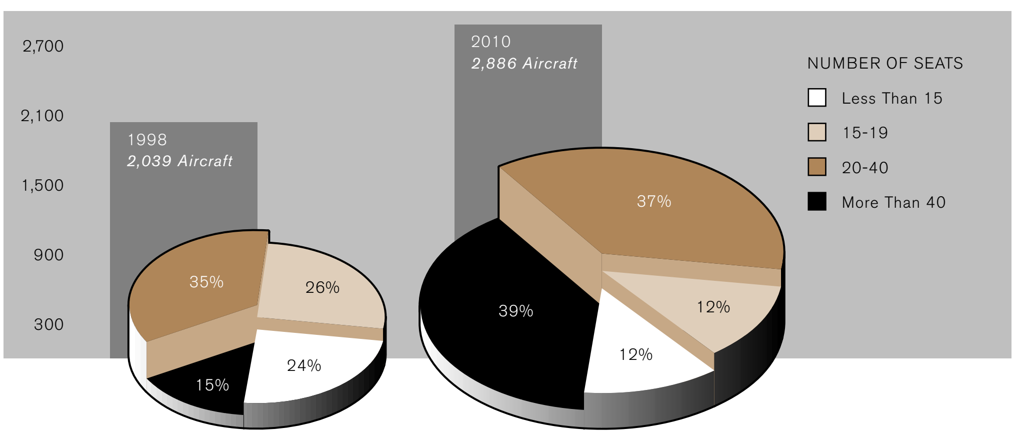
2.3 Regional Jet Aircraft

The large increase in the number of air carrier jet aircraft projected to be operational by 2010 is partially due to the increasing number of regional jets, expected to increase nearly six fold in the next 12 years, from 206 in 1998 to 1,195 in 2010.[5] The regional/commuter airline industry consists of air carriers that provide regularly scheduled passenger service with fleets that are primarily composed of aircraft with 60 seats or fewer, but up to 90 seats. Its main role is to provide feeder service to large hubs served by the major commercial air carriers.

Over the past several years, there has been a relatively rapid changeover of the commuter airline fleet from propeller-driven to jet aircraft. This fleet conversion allows the commuter airlines to extend their route structures to cities previously beyond the range of propeller aircraft, serve non-stop markets previously too small for direct service, and reduce the travel time in markets they already serve. The changeover from propeller to regional jet aircraft is expected to continue and accelerate, as passenger acceptance of jet aircraft has proven higher than for propeller aircraft.

From 1997 to 1998, regional/commuter enplanements increased 7.3 percent, compared to a 2.0 percent increase in all commercial enplanements. The regional/commuter aircraft fleet is projected to increase 2.9 percent annually, from 2,039 aircraft in 1998 to 2,886 in 2010, a total predicted increase of 42 percent. The shift to regional jets and larger propeller-driven aircraft will result in significant increases in the number of aircraft with 40 or more seats, enabling an 87 percent increase in regional/commuter enplanements by 2010.[6] Figure 2-9 shows the distribution of aircraft by number of seats in 1998 and projections for 2010.

Figure 2-9: Seat Capacity Mix of Regional/Commuter Aircraft—1998 vs. 2010



The use of regional jets by the commuter carriers has changed the distribution of traffic in the NAS. Regional jets can fly at higher altitudes than the propeller aircraft they are replacing. As this transition occurs, the number of aircraft using high altitude airspace may increase proportionately. In turn, the number of aircraft using low altitude airspace may decrease. The FAA will have to adjust air traffic control sectors if demand for airspace shifts from low altitude to high altitude sectors.

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5 U.S. Department of Transportation. *FAA Aerospace Forecasts Fiscal Years 1999–2010*, March 1999. Table 17 - U.S. Commercial Air Carriers, Jet Aircraft.

6 Ibid, Table-22

The changeover to regional jet aircraft will also affect terminal area airspace sectors. Controllers frequently assign departing propeller aircraft divergent headings from jet aircraft, since they will use a different altitude or route to exit the terminal area airspace. Divergent headings are used to increase departure runway capacity since in-trail separations are not required. With fewer propeller aircraft, the opportunity to use divergent headings is reduced. Terminal area airspace congestion may increase as more aircraft use routes that lead to high altitude airspace. In addition, many runways currently used by propeller aircraft may be too short to be used by regional jets.

2.4 General Aviation

General Aviation includes all segments of the aviation industry except commercial air carriers and the military. There were an estimated 194,826 active general aviation and air taxi aircraft in the U.S. in 1998. The FAA projects that the number of active GA aircraft will increase 13 percent by 2010, with business use expanding more rapidly than personal use of GA.[7] This projection assumes production of over 4,000 new GA aircraft and the retirement of approximately 2,000 older aircraft, annually.[8]

2.4.1 General Aviation Roadmap

The National Aeronautics and Space Administration (NASA) and the FAA have developed a strategic plan called the General Aviation Roadmap to stimulate the production and availability of safe, affordable, and fast GA aircraft over the next 25 years. The overall goal of the GA Roadmap initiative is to "enable doorstep-to-destination travel at four times the speed of highways to 25 percent of the nation's suburban, rural, and remote communities in 10 years and more than 90 percent in 25 years."

2.4.2 Small Aircraft Transportation System

One of the key elements of the GA Roadmap is the development of an intermodal, personal, rapid transit air travel system called the small aircraft transportation system (SATS). As envisioned by NASA and the FAA, the SATS aircraft will be faster, quieter, and more affordable than the GA aircraft currently in operation. Digital data link radios will bring real-time graphical weather and traffic information into the cockpit for display on satellite navigation moving maps. Coupled with the wide availability of GPS-based instrument approaches that provide access for landings in all but the most severe weather conditions, and the use of Automated Dependent Surveillance—Broadcast (ADS-B) systems for air traffic separation and sequencing, these new aircraft will allow more people to fly directly to their destinations.

Only 22 percent of public use airports are now equipped for precision instrument approaches. When precision approaches are possible at most public-use airports, new GA aircraft will increase access to suburban and rural communities that are currently not well served by hub-and-spoke facilities. Direct flights from any airport to suburbs and rural areas without passing through a hub airport will be commonplace, thus freeing up capacity at larger, capacity-constrained airports. In this way, traffic will increase at small, under-utilized airports, helping to relieve congestion and reduce delays at over-utilized airports. NASA and the FAA will involve various universities, manufacturers, and States in the development of SATS demonstration projects over the next decade.

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7 U.S. Department of Transportation. *FAA Aerospace Forecasts Fiscal Years 1999–2010*, March 1999. Table 23 - Active General Aviation and Air Taxi Aircraft.

8 Ibid, page V-15.

CHAPTER 3:
MEASURING SYSTEM CAPACITY AND PERFORMANCE

3 Measuring System Capacity and Performance

Capacity-enhancing programs, such as airport expansion, the modernization of air traffic control equipment, and the development of more efficient air traffic control procedures, are targeted at improving NAS performance. This chapter reports on four aspects of system capacity: delay, flexibility, predictability, and access. Trend information is provided where available, and a few key FAA strategies for enhancing each aspect of capacity are described. Figure 3-1 lists FAA capacity goals addressing each of these four aspects of system performance.

Figure 3-1: FAA Capacity Goals

DELAY

Air Traffic Volume

- Reduce delays due to air traffic volume.

Equipment

- Reduce delays due to equipment outages.
- Put into operational service 100 percent of the integrated systems needed to increase the safety, capacity, and efficiency of the NAS.
- Maintain operational availability of facilities required to provide automation, communication, navigation/landing, surveillance, and weather capabilities.

Weather

- Reduce delays due to weather.

Airports

- Increase system capacity attributable to runways at the 25 busiest airports.
- Maintain in good or fair condition at least 93 percent of runways at all commercial service and reliever airports, as well as selected general aviation airports.

FLEXIBILITY

Increase System Flexibility

- Reduce the number of published ATC-preferred routes.
- Increase the number of flight segments that aircraft are able to fly off ATC-preferred routes.

PREDICTABILITY

Increase System Predictability

- Increase the predictability of ground movement times.

ACCESS

Increase User Access

- Plan and develop a national system of airports that are accessible to 98 percent of U.S. residents.
- Increase the number of runways that are accessible in low visibility conditions.

The goals in this figure are reported in various documents, including the FAA Performance Plan, ATA Performance Plan, and the DOT Performance Plan.

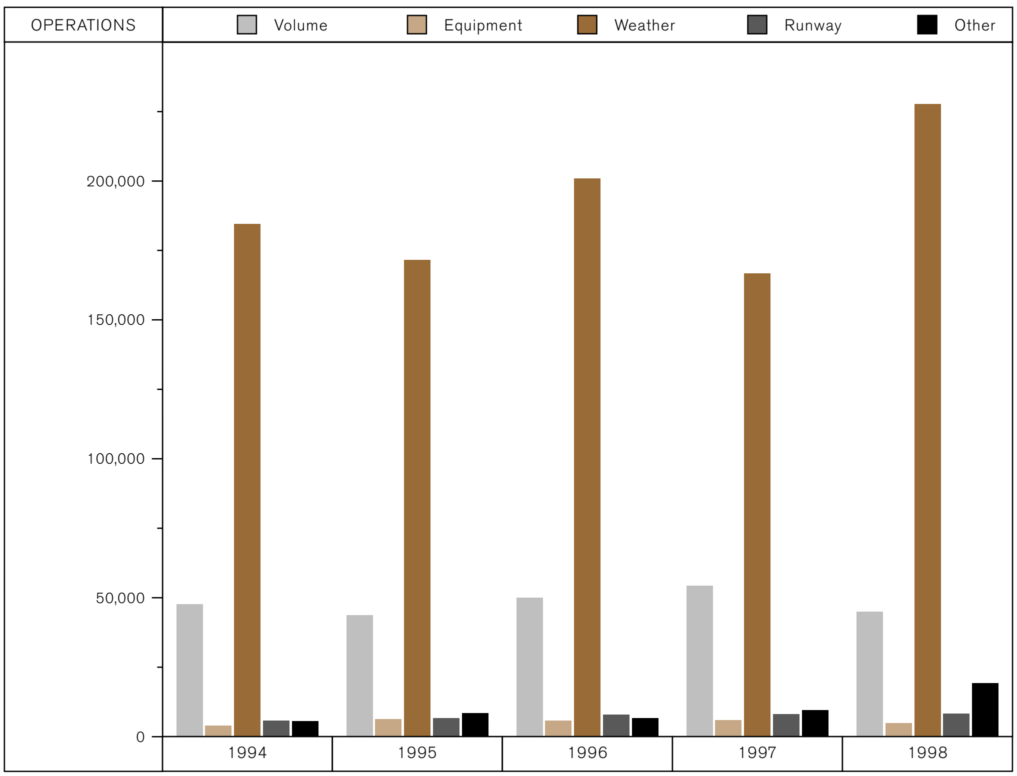
3.1 Delay

Delay, the difference between actual travel time and unimpeded travel time, is the traditional measure of NAS performance. Increased delays in 1998 through mid-1999 have caused the FAA to step up the pace of delay prevention measures.

3.1.1 Delay by Cause: Weather, Equipment, and Volume

Approximately 306,000 flights were delayed 15 or more minutes in 1998, an increase of nearly 25 percent from 1997, based on data from the FAA's Operations Network (OPSNET).[9] The primary causes of delay were weather and terminal traffic volume. Figure 3-2 shows trends in the distribution, by cause, of flights delayed 15 minutes or more.

Figure 3-2: Delay by Cause, by Calendar Year



Source: OPSNET

As of the publication date of this Plan, 1999 delay data for the entire calendar year is not available.

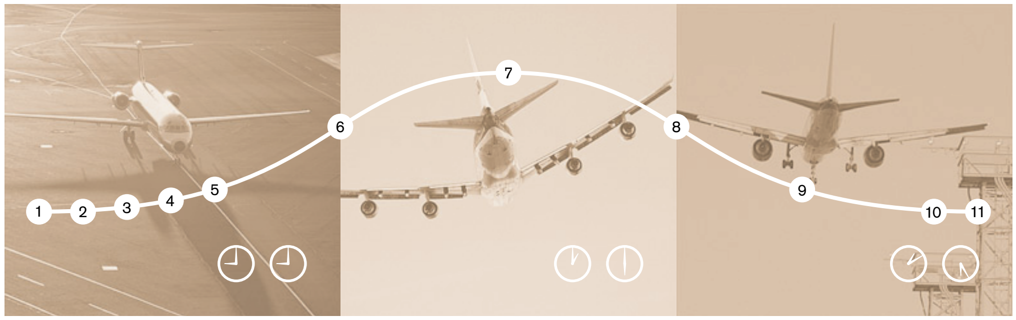
The large increase in delays from 1997 to 1998 was primarily the result of a 36 percent increase in weather-related delays. Weather delays, as a percentage of all delays, increased from 68 percent to 74 percent.

3.1.2 Delay By Phase of Flight

Delays may take place during any phase of a flight. Figure 3-3 portrays the phases of a flight and identifies potential causes of delay.

9 Operations Network (OPSNET) is an FAA delay reporting system. The data is derived from observations by FAA personnel, who manually record aircraft that are delayed by 15 minutes or more. Aircraft that are delayed by less than 15 minutes are not recorded.

Figure 3-3: Anatomy of a Flight



Phase of Flight	Airline Action	Potential Delay Causes	Magnitude of Potential Delays	Typical Time of Flight
1 Pre-Departure	File Flight Plan	None	None	0-30 days
2 Request Departure	Activate Flight Plan	FAA Slot Assignment	0-180 mins	10-30 mins
3 Activate Departure	Request Push-Back Request Taxi Clearance	FAA Approval Congestion in Taxiway	0-30 mins	At Departure
4 Taxi Out	Taxi Out Departure Queue	Congestion on Taxiway Runway	0-60 mins	2-10 mins
5 Take-Off	Request Take-Off Clearance	Congestion in Local and Regional Airspace Congestion on Runways	0-1 min	1 min
6 Climb Out	Climb Out	Congestion in Regional Airspace	0-3 mins	15-30 mins
7 Cruise	Cruise	Congestion in National Airspace Congestion at Destination Airport	0-30 mins	0-14 hrs
8 Descent	Descend	Congestion in Local Airspace Congestion at Destination Airport	0-15 mins	15-30 mins
9 Landing	Landing	None	None	1 min
10 Taxi In	Taxi In	Gate Availability Taxiway Congestion	0-30 mins	5-10 mins
11 Arrive at Gate	Set Brake, Open Door	None	None	None

Source: Landrum & Brown, Inc.

Figure 3-4 ranks 28 of the 30 large-hub airports (HNL and IAD are excluded) by average minutes of delay for each phase of flight, based on data from the Consolidated Operations and Delay Analysis System (CODAS).[10] Newark International and La Guardia had the highest taxi-out delay and the highest average delay for all phases of flight, respectively.

10 CODAS is an FAA database and reporting system containing delay information by phase of flight for U.S. domestic flights. CODAS contains actual times for gate out, wheels off, wheels on, and gate in. From this information, CODAS computes delays the flight experiences as it moves through the national airspace system, broken down by phase of flight into gate delays, taxi out delays, airborne delays, and taxi in delays. CODAS measures delay where it occurs in the NAS, and does not address why it happens.

Figure 3-4: Large-Hub Airports Ranked by Average Minutes of Delay—Calendar Year 1998

	Taxi-Out Delay		Airborne Delay		Taxi-In Delay		Delay Per Operation	
Rank	APT	MIN/DEP	APT	MIN/ARR	APT	MIN/ARR	APT	MIN/OP
1	EWR	12.5	ATL	6.6	DTW	3.5	EWR	10.8
2	LGA	10.3	EWR	6.4	DFW	3.1	LGA	8.6
3	ATL	7.2	PHL	5.8	ATL	2.2	ATL	8.2
4	JFK	7.1	BOS	4.7	STL	2.2	PHL	7.5
5	STL	6.9	LGA	4.6	EWR	2.2	STL	6.7
6	PHL	6.6	MSP	4.3	LAX	2.1	JFK	6.6
7	IAH	6.2	SLC	4.3	ORD	2.0	MSP	6.4
8	MSP	6.0	CVG	4.3	MSP	2.0	DTW	6.3
9	DTW	5.8	SFO	4.1	JFK	1.9	BOS	6.2
10	ORD	5.7	PIT	4.1	BOS	1.8	IAH	5.9
11	DFW	5.2	CLT	3.8	MIA	1.8	ORD	5.8
12	BOS	5.1	STL	3.8	PHL	1.7	DFW	5.7
13	SFO	5.0	SEA	3.6	LGA	1.6	SFO	5.6
14	CVG	5.0	ORD	3.4	IAH	1.6	CVG	5.3
15	PHX	4.5	JFK	3.4	DEN	1.4	SLC	5.0
16	DCA	4.3	IAH	3.2	LAS	1.4	MIA	4.6
17	MIA	4.1	DTW	2.9	PHX	1.3	LAX	4.6
18	SLC	3.9	MIA	2.7	SFO	1.3	PHX	4.5
19	CLT	3.7	DFW	2.7	SLC	1.1	CLT	4.5
20	LAX	3.7	MCO	2.3	DCA	0.9	PIT	4.4
21	PIT	3.5	DCA	2.3	SEA	0.9	SEA	4.2
22	LAS	3.4	DEN	2.3	CLT	0.8	DCA	4.1
23	DEN	3.1	LAX	2.3	PIT	0.7	DEN	3.8
24	SEA	3.0	PHX	2.2	CVG	0.7	LAS	3.6
25	MCO	2.6	TPA	2.1	MCO	0.7	MCO	3.2
26	SAN	2.5	BWI	2.0	BWI	0.6	SAN	2.9
27	BWI	2.2	SAN	1.5	TPA	0.5	BWI	2.7
28	TPA	1.7	LAS	1.3	SAN	0.5	TPA	2.5

Excludes data for Honolulu (HNL)

Excludes data for Washington Dulles (IAD) which will be included in next year's ACE Plan

Definitions

Taxi-Out Delay *– Actual taxi-out time minus unimpeded taxi-out time*

Airborne Delay *– Actual airborne time minus carrier submitted flight plan time*

Taxi-In-Delay *– Actual taxi-in time minus unimpeded taxi-in time*

Delay Per Operation *-– An operation is an arrival or departure. When calculating delay per operation, airborne delays are attributed to the arrival airport and exclude air carrier delay due to late crew, baggage, or other carrier-related activity.*

Source: CODAS

3.1.3 Identification of Congested Airports

The FAA considers an airport to be congested if the average delay per operation exceeds five minutes. In 1998, 15 large-hub airports met that standard. The FAA conservatively projects that 21 large-hub airports will be congested by 2008. Airport capacity was assumed to be unchanged in making those projections. In fact, a number of these airports have runway projects under way or planned for the near future, which should reduce delays. Figure 3-5 shows the number of operations for 1998, and projected operations for 2008, for congested airports.

Figure 3-5: Large-Hub Airports Exceeding Five Minutes of Delay per Operation
Calendar Years 1998 and 2008

Year 1998	Year 2008 [1]	1998	2008 [2]	
Airport	**Airport**	**Total Ops (1000)**	**Total Ops (1000)**	**Growth (%)**
Atlanta Hartsfield	Atlanta Hartsfield	832	1,089	31
Boston Logan	Boston Logan	512	553	8
	Charlotte/Douglas	452	518	15
Cincinnati	Cincinnati	438	603	38
Dallas-Ft. Worth	Dallas-Ft. Worth	945	1,215	29
Detroit	Detroit	531	664	25
Newark	Newark	461	555	20
George Bush Intercontl	George Bush Intercontl	440	638	45
New York John F. Kennedy	New York John F. Kennedy	362	399	10
	Los Angeles	786	989	26
New York La Guardia	New York La Guardia	356	372	4
	Miami	537	687	28
Minneapolis-St. Paul	Minneapolis-St. Paul	481	640	33
Chicago O'Hare	Chicago O'Hare	888	1,018	15
Philadelphia	Philadelphia	465	596	28
	Phoenix	523	678	30
	Pittsburgh	451	539	20
	Seattle	400	500	25
San Francisco	San Francisco	435	563	29
Salt Lake City	Salt Lake City	365	488	34
St. Louis	St. Louis	506	585	16

(1) Assumes no capacity improvement
(2) Terminal Area Forecast
Source: CODAS

3.1.4 Strategies to Reduce Delay

Reducing flight delays is complicated by the steadily increasing number of aircraft operations throughout the NAS. In this environment, the FAA is striving to reduce delays through a variety of approaches. Financing the construction of new runways increases the capacity of existing airports, while new equipment expands the capability of the air traffic system.

Adverse weather is the most common cause of delay. Although these delays are difficult to influence, the FAA is developing several automated weather information systems to provide pilots and controllers with better information about upcoming weather. For example, the Weather and Radar Processor (WARP) will overlay weather information on computer displays to assist controllers in managing traffic, thereby minimizing weather-related delays. Another system, the Integrated Terminal Weather Information System (ITWS), an automated weather-prediction system, will give controllers better information on near-term weather hazards within 60 nautical miles of an airport, allowing them to more efficiently merge and sequence aircraft in the terminal area.

Other approaches to reducing delays include enhancing the capabilities of the Command Center to manage the use of air traffic control restrictions in eliminating daily traffic bottlenecks and the development of improved approach procedures. The simultaneous offset instrument approach, for example, will increase capacity at airports with closely spaced parallel runways. These and other strategies to reduce weather, terminal, and other delays are described in greater detail later in this Plan.

3.2 Flexibility

Flexibility is the extent to which the air traffic control system allows users to optimize their operations. User needs vary daily and from one flight to another. NAS users want to plan their flights, with a minimum of restrictions imposed by the FAA. Improved system flexibility will permit real-time adjustments, more efficient routing, and better scheduling.

3.2.1 Measures of Flexibility

ATC-preferred routes help air traffic controllers organize traffic flows. They are generally not the most direct routes, so reducing the number of ATC-preferred routes will allow more efficient routing and improved scheduling efficiency. In 1998, there were 1,976 high-altitude ATC-preferred routes. Through the published preferred route reduction program, the FAA is evaluating ATC-preferred routes and eliminating them where the restrictions are no longer required because of the availability of better navigation equipment and enhanced procedures.

The FAA set a target of eliminating seven percent of ATC-preferred routes by the end of 1999 and a total of 24 percent by the end of 2002. The FAA eliminated 170 routes in 1999, slightly more than the target. Four hundred additional routes are currently being evaluated. The FAA is also beginning to focus its flexibility efforts on improving and measuring the availability of user-preferred routes.

3.2.2 Strategies to Improve Flexibility

To increase system flexibility, the FAA is moving air traffic services from positive control to collaborative decision making. To that end, the FAA is introducing new procedures and infrastructure that are changing the way services are provided to NAS users. For example, the FAA is developing area navigation (RNAV) routes and procedures in every region of the U.S.; these are providing pilots more opportunities for direct routing. Similarly, the North American Route Program (NRP), which allows direct routing at or above FL290, will be enhanced by the development of departure procedures and standard terminal arrival routes to increase the flexibility of pilots as they transition to and from the NRP area. The User Request Evaluation Tool (URET) is an example of a technological approach to increasing flexibility. URET uses flight plan and radar data to build flight trajectories for all flights within or inbound to an ARTCC and detects potential separation conflicts up to 20 minutes in advance. With this information, controllers can more effectively manage user requests for altitude or route changes. These and other strategies to increase flexibility are described in greater detail later in this Plan.

3.3 Predictability

Predictability is the variation in the air traffic management system as experienced by the user. System predictability allows users to plan and manage their resources efficiently. The majority of NAS users rely on schedules that define when aircraft take off and land. These schedules are central to the operations of most commercial flights, driving crew scheduling, ground service, and other operational components. Near-term decisions, such as scheduling and planning flights, as well as longer-term decisions such as fleet size, airframe types, and hubbing, are all impacted by the day-to-day variation of NAS performance. Scheduled operations are very dependent on system predictability since relatively small deviations can have drastic impacts, especially when ripple effects throughout the system are taken into account.

Increasing information flow to system users is a key ingredient to improved system predictability. Enhancement of collaborative decision making will ensure that information on air traffic and flight conditions can be shared by controllers and NAS users. Having more information will make operations more predictable. A technological approach to enhancing predictability is the implementation of the surface movement advisor (SMA). SMA provides aircraft identification and real-time position information on flight arrivals to airport controllers and airport ramp control personnel. This type of communication allows enhanced management of ground support services, faster aircraft turnarounds, and more consistent taxi-out times. These and other strategies to increase predictability are described in greater detail later in this Plan.

3.4 Access

Access is the ability of NAS users to access airports, airspace, and services. Access to the air traffic system, airports, airspace, and other FAA services are basic needs of all NAS users.

3.4.1 Measures of Accessibility

Although many aspects of system accessibility affect NAS users, a current FAA focus is increasing the number of airports with precision approaches, which will improve airport accessibility in low-visibility weather conditions. Increasing low-visibility access depends on increasing both the number of published precision approaches and the number of aircraft equipped to make precision approaches. Developing precision approaches requires accurate survey information for airport runway location and any obstacles near the approach flight path.

Currently, about 600 airports have an instrument landing system (ILS) for precision approaches during low-visibility conditions. Because many of these airports have more than one runway, the total number of runways with precision landing guidance (which includes altitude guidance) is approximately 1,080.

The FAA is transitioning from ground-based landing aids such as an ILS to an augmented GPS. To maximize airport accessibility in low-visibility conditions, the FAA will need to develop approaches for all qualifying airports that do not currently have electronic aids to support an instrument approach, and aircraft not presently equipped will need to install a GPS Wide Area Augmentation System receiver. The FAA's goal is to increase the number of runways that are accessible in low-visibility conditions by ten percent by the end of 2001, and by fifteen percent by the end of 2002.

3.4.2 Strategies to Improve Access

The FAA is constantly working to improve access for all NAS users to airports, airspace, and aviation services. Development of augmented GPS for precision approaches will give appropriately equipped and trained GA users access to more airports than ever before. Access to available military special use airspace (SUA) is being enhanced through the Special Use Airspace Management System (SAMS), which provides information on SUA status to controllers and other systems will make this data available directly to NAS users in the near future. The Operational and Supportability

Implementation System (OASIS), which will replace the existing flight service automation system, will provide GA users with improved access to flight planning services and weather information.

3.4.3 Department of Transportation Initiatives to Improve System Access

The U.S. Department of Transportation (DOT) has undertaken several initiatives to improve passenger access to the U.S. aviation system. These initiatives involve the FAA, but are administered by DOT. These include the following:

- DOT recently embarked on a new, intermodal approach to transportation planning, called the ONE DOT management strategy. The FAA will participate in this program by considering the entire transportation experience for the flying public when determining its investments in airports and other aviation infrastructure. Examples of such initiatives include cooperation between the Federal Transit Authority and the FAA in developing light rail transit systems for JFK International in New York, Lambert Field in St. Louis, and other airports.
- A key provision of the deregulation of the airline industry in 1978 was the establishment of the Essential Air Service (EAS) program to guarantee eligible communities a minimum level of service. Under this program, air carriers are subsidized to provide scheduled air service if no other carrier is willing to provide the service subsidy-free. At least through 2000, all eligible communities will have access to at least two round trip flights per day.
- International air transportation has been subject to restrictive bilateral agreements with other countries since the 1940's. These agreements tend to raise prices and artificially suppress aviation growth in these markets. The International Air Transportation Policy Statement, issued by DOT in 1995, aims to open international air travel to market forces. DOT's goal is to achieve at least a three percent annual growth rate in those international markets with open aviation agreements and to remove many of the bilateral restrictions.

CHAPTER 4: NATIONAL AIRSPACE SYSTEM MODERNIZATION

4 National Airspace System Modernization

National Airspace System Modernization is a long-term effort to accommodate air traffic growth and to meet the increased safety and efficiency demands placed on the air traffic control system. The NAS is comprised of a complex network of facilities, systems, equipment and airports, which operate 24 hours a day and 365 days a year. Because most changes—whether the installation of new equipment or the implementation of new procedures—must take place while aircraft are active, even simple tasks can be very difficult. Maintaining the system's level of safety while these changes take place requires careful planning and execution. Ongoing and proposed improvements of this modernization effort will lead to enhanced capabilities such as:

- Increased ability of users to fly more direct routes
- Expanded surveillance coverage
- Clearer, less congested air/ground communications
- Optimized flight profiles
- More efficient sequencing of air traffic
- Accurate and timely weather and traffic information in the cockpit

Free Flight is the impetus for many of the changes of NAS Modernization. Free Flight gives pilots greater flexibility and discretion in determining routes and speeds. As the move toward free flight continues, NAS users will face fewer restrictions in their flight operations, resulting in more choices, fewer delays, and lower operating costs.

4.1 Capacity-Enhancing Systems

NAS Modernization projects that address capacity are broadly categorized in three functional areas, as follows:

- Communications, navigation, and surveillance systems
- Weather detection and reporting systems
- Air traffic decision support systems

The following sections of this chapter are organized within these three categories. Each section contains a table with brief descriptions of selected systems and their projected benefits to airspace and airport capacity. The capacity benefits for each technology are described, with specific delay or cost savings given when possible. While new and developing technologies are highlighted, many capacity benefits will be gained from incremental upgrades to existing systems or new applications of existing technologies.

Following the tables, each section has a figure showing deployment schedules for the corresponding technologies. Because these schedules can be complex and are subject to change, the figures show only estimated deployment dates. More detailed schedules and information about each system discussed in this section can be found in the FAA's NAS Architecture Version 4.0.

A number of the technologies described in this chapter (such as the traffic management advisor and the surface movement advisor) have been developed through the cooperative efforts of NASA and the FAA. NASA's aviation system capacity program conducts several joint research projects with the FAA under an inter-agency integrated product team.

4.1.1 Communication, Navigation, and Surveillance Systems

NAS Modernization will provide technologies that will significantly enhance today's communication, navigation, and surveillance (CNS) capabilities. Satellite navigation and data link technologies are the central features of the next generation of CNS systems. These technologies and their associated services will encompass all operational environments, from the airport surface through all phases of flight. Because CNS technologies rely heavily on the flow of electronic data, the efficient use of the frequency spectrum will be paramount in realizing the full efficiency gains expected. New CNS systems will bring many capacity benefits, including:

- More efficient use of airspace
- Greater route flexibility
- Reduced separation standards
- Greater on-demand access to important aeronautical information
- More efficient use of frequencies (less congestion)
- Enhanced situational awareness for pilots and controllers
- Seamless communications across all operational environments
- Increased access to airports in poor weather through more precision approaches
- More precise monitoring of aircraft in oceanic airspace
- Enhanced airport surface surveillance

Table 4-1 and Figure 4-1 describe CNS technologies and show their deployment schedules, respectively.

Table 4-1: Communication, Navigation, and Surveillance Systems Summary Descriptions

Controller to Pilot Data Link Communications (CPDLC) will replace sets of controller/pilot voice messages with data messages displayed in the cockpit. The initial version of CPDLC, Build 1, uses a combination of analog and digital data link technologies and provides an incremental step for implementing en route data links. CPDLC Build 1A, Build 2, and Build 3 will expand the message set to include additional key flight data, and will transition to a fully integrated all-digital system. *Capacity Benefits: Improves the speed, quality, and reliability of controller/pilot communications, leading to reduced congestion on voice channels and fewer missed communications and misinterpretations. Improves access to flight information.*
Next Generation Air/Ground Communication System (NEXCOM) is a digital radio system capable of accommodating both analog and digital communication. *Capacity Benefits: Improves frequency spectrum efficiency by increasing the number of available voice circuits and providing for simultaneous use of a frequency for both voice and data communication. Reduces frequency change errors and air/ground radio frequency interference.*
Automated Dependent Surveillance (ADS-A) is a surveillance system that exchanges point-to-point position information between a specific aircraft and air traffic management facility. It is primarily used in areas having poor or no radar coverage, such as in oceanic airspace. *Capacity Benefits: Allows for more efficient merging of traffic from multiple oceanic tracks and enables the expanded use of oceanic in-trail climb and descent procedures. Increases the number of approvals for user-preferred routes and altitudes in areas not covered by radar.*
Automated Dependent Surveillance (ADS-B) is a surveillance system that continuously broadcasts GPS position information, aircraft identification, altitude, velocity vector, and intent information to all aircraft and all air traffic management facilities within a specified area. The **Cockpit Display of Traffic Information (CDTI)** system will show pilots the relative position and movement of ADS-equipped aircraft in their vicinity. On the airport surface, ADS-B and CDTI will be used to assist in taxi operations. *Capacity Benefits: Provides pilots with greater awareness of local traffic, allowing for closer spacing and more discretion in movement (e.g., change routes mid-flight if winds are not as forecast). On the airport surface, ADS-B provides more efficient and safe movement in poor weather and at night.*

The **Global Positioning System (GPS)** is a satellite-based navigation system with worldwide coverage. GPS is already being used for navigation in oceanic and en route airspace. Two independent augmentations of the basic GPS signal, the **Wide Area Augmentation System (WAAS)** and the **Local Area Augmentation System (LAAS)**, will extend GPS navigation and landing capabilities to airports throughout the NAS. WAAS will provide en route, terminal, non-precision, and selected Category I precision approach capability throughout the NAS. LAAS will provide Category II/III precision approach and landing capability, accurate navigation signals for aircraft and vehicles on the airport surface, and Category I capability at those locations where WAAS cannot do so.

Capacity Benefits: Permits more direct routing and provides more non-precision and precision approaches. Facilitates reduced separation standards and enhances surface navigation and surveillance capabilities. Extends these benefits to GA pilots at a relatively low cost.

The **Flight Information Service (FIS)** provides a variety of advisory information directly to the cockpit such as weather products, traffic information, Special Use Airspace status, Notices to Airmen, and obstruction updates.

Capacity Benefits: Reduces delays by increasing flight planning capabilities. Facilitates direct routing by giving pilots more information on current traffic, environmental conditions, terrain, and NAS resource availability.

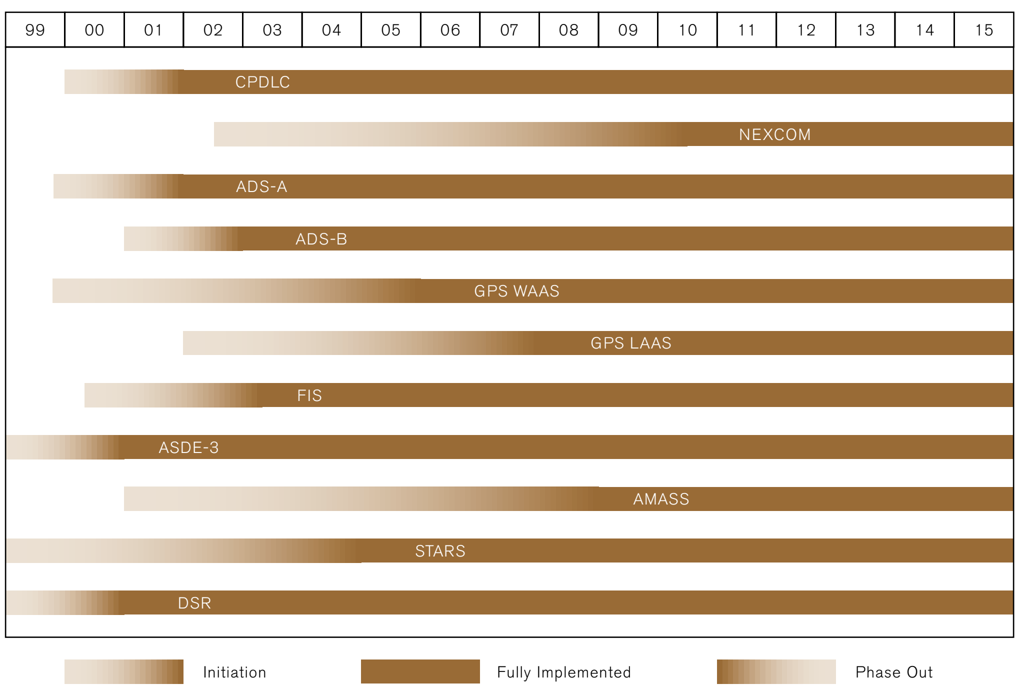
The **Airport Surface Detection Equipment (ASDE-3)** is a high-resolution ground mapping radar that provides surveillance of taxiing aircraft and service vehicles at high-activity airports. The **Airport Movement Area Safety System (AMASS)** enhances the function of the ASDE-3 radar by providing automated alerts and warnings to potential runway incursions and other hazards.

Capacity Benefits: Allows for more efficient airport surface movement during low visibility conditions.

The **Standard Terminal Automation Replacement System (STARS)** is a computer system for terminal airspace with advanced displays. STARS supports radar target identification and separation, traffic and weather advisory services, and navigational assistance to aircraft. STARS also provides the platform for data link communications and **Center—TRACON Automation System (CTAS)** and **Final Approach Spacing Tool (FAST)**. The **Display System Replacement (DSR)** is the replacement controller workstation and display for the en route airspace. The DSR supports weather data and enables controllers to use decision support systems.

Capacity Benefits: STARS and DSR support current and future surveillance technology, traffic and weather information systems, and sequencing and spacing tools.

Figure 4-1: CNS Deployment Schedule



4.1.2 Weather Detection and Reporting Systems

Weather is the single largest cause of delay in the NAS. Low ceilings, poor visibility, and high winds within terminal areas are the major causes of this delay, especially when these conditions are unexpected. To reduce weather-related delays, new weather technologies are focused on providing an integrated set of easy-to-interpret, near real-time weather information to all NAS users.

This weather information will be displayed as enhanced graphics on new screens in ATC facilities and aircraft cockpits. Additionally, the weather information itself will be improved through the use of better sensors, improved data sources, and automated systems. Data links will again be essential to the timely dissemination of weather information to flight crews. Capacity benefits associated with improvements in weather systems include:

- ➢ Improved planning for fuel and time-efficient flight plans
- ➢ Better separation of aircraft from convective weather
- ➢ Improved accuracy, display, and timeliness of weather information
- ➢ NAS-wide availability of distributed weather forecast data
- ➢ Common situational awareness among weather information providers and users

Table 4-2 and Figure 4-2 describe weather detection and reporting systems and show their deployment schedules, respectively.

Table 4-2: Weather Systems Summary Descriptions

Integrated Terminal Weather System (ITWS) is an automated weather-prediction system installed at ARTCCs that gives both air traffic personnel and pilots better information on near-term weather hazards in the airspace within 60 nautical miles of an airport. ITWS integrates data from radar, weather sensors, and automated aircraft reports and presents the information in easily understood graphics and text. ITWS can generate predictions of weather phenomena such as microbursts, gust fronts, storm cell movements and runway winds up to 30 minutes in advance. ITWS can also display data on the presence of lightning, hail, and tornadoes. Additionally, the system will display weather data in tower cabs, TRACONs, and ARTCCs to facilitate coordination among air traffic control personnel. *Capacity Benefits: Improves the FAA's ability to minimize delays caused by localized, hazardous weather. Using information provided by ITWS, controllers will be able to more efficiently merge and sequence aircraft in the terminal area. Additionally, ITWS enhances the capability of decision-support tools in making accurate aircraft trajectory predictions.*
Weather and Radar Processor (WARP) is an en route system that provides an array of weather information to controllers, traffic management specialists, pilots, and meteorologists. WARP receives input from NEXRAD, meteorological observations, warnings, forecasts, lightning strikes, satellite data, and oceanographic information. Weather information significant to operations is sorted and overlaid on advanced controller displays. *Capacity Benefits: Assists meteorologists in analyzing rapidly changing weather conditions, which in turn assists controllers in better managing traffic and minimizing weather-related delays. WARP also provides access to advanced, integrated weather information for all NAS users.*
Terminal Doppler Weather Radar (TDWR) is a radar capable of detecting localized hazardous weather in the terminal area. The radar provides alerts and advanced notice of changing conditions. *Capacity Benefits: Provides for more efficient arrival and departures during severe weather near airports and allows for rapid changes of active runways.*

The **Airport Surveillance Radar—Weather System Processor (ASR-WSP)** is an enhancement to the ASR-9 radar, providing it with a wind shear and microburst weather detection capability. This system is intended for airports not equipped with TDWR. The system provides controllers with accurate, current, and predictive information that allows for better assessment of impacts on terminal area operations.

Capacity Benefits: By providing greater severe weather detection capabilities at airports not equipped with TDWR, the ASR-WSP allows for more efficient arrival and departures during severe weather.

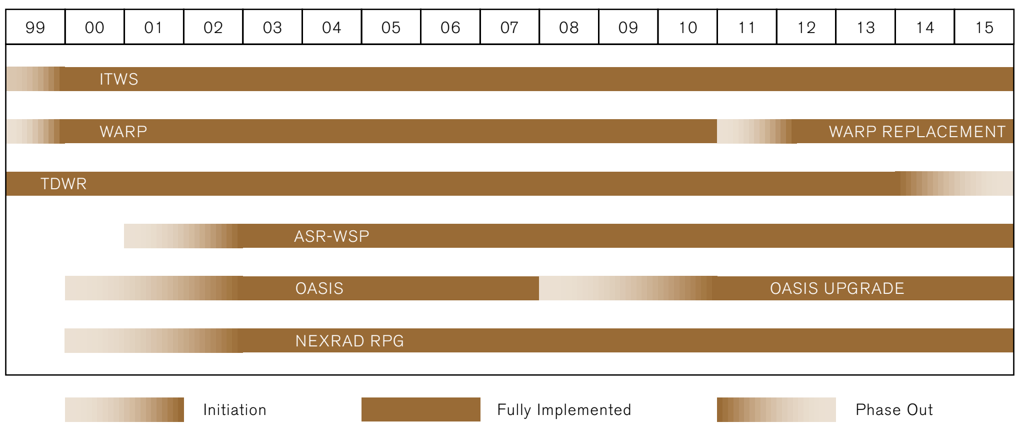
The **Operational and Supportability Implementation System (OASIS)** is a graphical flight planning system that provides advanced weather products including an integrated display of weather and flight route information. OASIS can acquire, display, and store near real-time weather radar images and products, weather satellite imagery, and lightning detection data.

Capacity Benefits: Provides users with access to a single, integrated source for improved weather products.

The **Next Generation Weather Radar (NEXRAD) Radar Product Generator (RPG)** is an upgrade to the existing NEXRAD that increases processing capabilities and accuracy. Later evolutions will include capabilities for predicting hazardous weather.

Capacity Benefits: Provides greater accuracy in detecting hazardous weather than its predecessor, and allows controllers to better manage traffic in the vicinity of hazardous weather.

Figure 4-2: Weather Systems Deployment Schedule



4.1.3 Air Traffic Decision Support Systems

Efficient and safe traffic flow management (TFM) requires the effective use of operational data pertaining to traffic, weather, schedule, performance, and infrastructure. Using data, traffic managers seek to increase airspace and airport capacity through strategic planning, tracking, and tactical control of aircraft. One of the most successful users of TFM has been the Command Center's Collaborative Decision Making program, which was described in Chapter 1.

Much of the success of TFM relies on advances being made in decision support systems (DSSs). These tools assist managers in the early prediction and resolution of potential traffic congestion, and provide them with greater flexibility in planning operations. The capacity benefits derived from DSSs include:

➢ Greater collaboration on problem resolution through dynamic airspace management
➢ More efficient use of airports through improved sequencing and spacing of arrival traffic, and assigning aircraft to runways
➢ Improved acquisition and distribution of flight-specific data
➢ More information from static and dynamic data (e.g., route structures, NAS infrastructure status, special use airspace restrictions, aircraft position and trajectories)

- ➢ Expanded accommodation of user preferences through improved traffic flow management, conflict detection and resolution, sequencing, and optimal trajectories
- ➢ More flexible airspace structure by reducing boundary restrictions and creating dynamic sectors

Table 4-3 and Figure 4-3 describe decision support systems and show their deployment schedules, respectively.

Table 4-3: Decision Support Systems Summary Description

The **Passive Final Approach Spacing Tool (pFAST)** helps controllers select the most efficient arrival runway and arrival sequence within 60 nautical miles of an airport, considering aircraft type, speed, and trajectory. **Active FAST (aFAST)** will enhance pFAST capabilities by helping controllers determine how to vector aircraft onto final approach.

*Capacity Benefits: Increases terminal airspace efficiency by optimizing arrival flows. The system also optimizes runway usage for arrivals and departures and enables more efficient use of runway capacity during peak traffic periods. A prototype pFAST at the Dallas-Ft. Worth TRACON has demonstrated an increase in arrival throughput ranging from 4.2 percent to 13 percent during peak periods. Economic benefits derived from pFAST through 2009 have been estimated at nearly $2 billion.**

The **Traffic Management Advisor (TMA)—Single Center (SC)** provides en route controllers and traffic management coordinators with automation tools to manage the flow of traffic from a single center into selected major airports, with consideration given to separation, airspace, and airport constraints. Long term improvements include a **TMA multi-center (TMA MC)** capability to enable multiple ARTCCs to meter arrivals into a single terminal, and a descent advisor, which will provide optimized descent point and speed advisories to controllers based on aircraft type. TMA and pFAST together constitute the **Center Terminal Radar Approach Control Automation System (CTAS)**. CTAS combines the capabilities of these systems to help controllers efficiently descend, sequence, and space arriving aircraft within 200 nautical miles of an airport.

*Capacity Benefits: Optimizes arrival flows from centers into the terminal area. Installations of the TMA prototypes at the Miami, Los Angeles, and Atlanta centers were operated throughout 1997, with preliminary results showing delay reductions of 1 to 2 minutes per aircraft during peak periods. Total cost savings of the TMA SC through 2009 have been estimated at $1 billion.**

The **User Request Evaluation Tool (URET)** is a system that extracts real-time flight plan and tracking data from the host computer, builds flight trajectories for all flights within or inbound to the ARTCC, and identifies potential separation conflicts up to 20 minutes in advance.

*Capacity Benefits: Allows greater route flexibility and more efficient routings in en route airspace by enabling controllers to more effectively manage user requests. The conflict detection capability will be especially useful in permitting user requests in oceanic airspace. Savings from URET have been estimated at $524 million over the next 10 years.**

The **Surface Movement Advisor (SMA)** is a system that promotes sharing of dynamic surface-related information among airlines, airport operators, and air traffic controllers in order to control the efficient flow of aircraft and vehicles on the airport surface. The system provides prediction capabilities to controllers to help them more efficiently manage operational resources and to optimize airport configurations. The **Surface Management System (SMS)**, evolved from the SMA, will provide airport configuration, aircraft arrival/departure status, and airfield ground movement advisories to controllers, dispatchers, and traffic flow managers

*Capacity Benefits: The SMA, through more efficient coordination of information and enhanced management of ground support services, allows for faster aircraft turnarounds, reduced communications, fewer unnecessary diversions and reduced taxi times and takeoff delays. Results of an SMA prototype evaluation at the Hartsfield Atlanta International in 1997 show a reduction in taxi times of more than one minute per operation, or over 1,000 minutes per day. Limited deployment of SMA through 2006 will bring approximately $500 million in savings.**

The **Flight Schedule Monitor (FSM)**, a primary component of CDM, is a support tool that collects and displays arrival information, retrieves real-time demand and schedule information, monitors ground delay performance, and provides "what if" analyses capable of projecting arrival rates, slot availability, and departure delays. The FSM is shared among CDM participants and is updated as schedules change.

Capacity Benefits: Optimizes operations by seeing where delays are located and making necessary schedule arrangements (e.g., cancel flights).

The **Collaborative Decision Making Network (CDMNet)** is a private intranet that provides an enhanced capability for the FAA and airline operations control centers to rapidly exchange a single integrated source of aeronautical information concerning delays and constraints in the NAS.

Capacity Benefits: Improves airlines' ability to manage flight delays by letting them make informed operational decisions in real time.

* *Estimates taken from the Free Flight Phase 1 Objective Assessment Report, Version 3.1, Federal Aviation Administration, Investment Analysis and Operations Research Division (ASD-400), June 1999. Benefits include savings in airline direct operating costs and passenger value of time. These estimates are based on preliminary functionality anticipated for the tools when FFP1 began. Actual functionality may vary and so will the benefits. The FFP1 Program Office is currently undertaking an effort to specifically measure actual benefits.*

Figure 4-3: Decision Support Systems Deployment Schedule

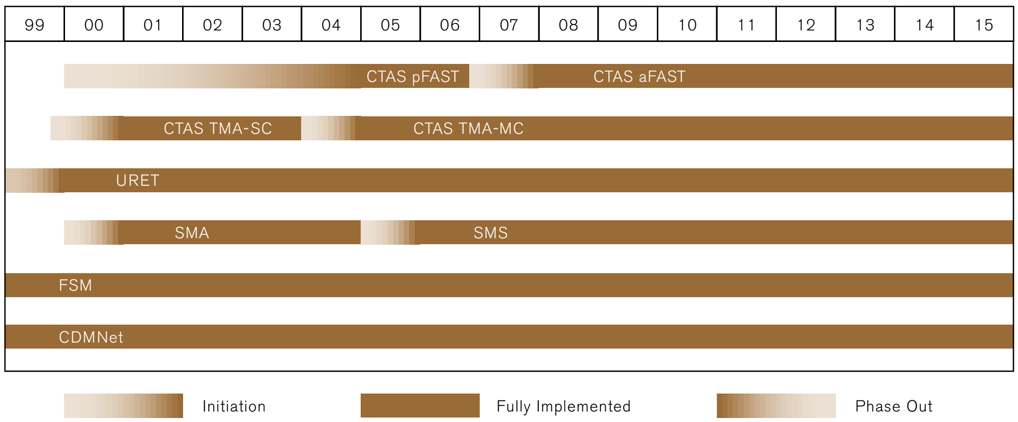


Figure 4-4, below, shows the technologies to be employed during different phases of flight. Most of these technologies will be deployed within the next five years.

Figure 4-4: Technology Systems Employed by Phase of Flight

	Pre-Departure	Request Departure	Activate Departure	Taxi Out	Take-Off	Climb Out	Cruise	Descent	Landing	Taxi In
Communication			CPDLC NEXCOM	CPDLC NEXCOM	CPDLC NEXCOM	CPDLC NEXCOM FIS	CPDLC NEXCOM FIS	CPDLC NEXCOM FIS	CPDLC NEXCOM	CPDLC NEXCOM
Navigation				GPS/LAAS	GPS/LAAS	GPS/WAAS	GPS/WAAS	GPS/WAAS	GPS/LAAS	GPS/LAAS
Surveillance				AMASS ASDE ADS-B STARS/DSR	NEXRAD ADS-B STARS/DSR	NEXRAD ADS-B STARS/DSR	NEXRAD ADS-B	NEXRAD ADS-B STARS/DSR	NEXRAD ADS-B STARS/DSR	AMASS ASDE ADS-B STARS/DSR
Weather	OASIS				ASR-WSP TDWR	ITWS TDWR ASR-WSP	WARP	ITWS TDWR ASR-WSP	ASR-WSP TDWR	
Decision Support Systems	FSM CDMNet	SMA	SMA	SMA		URET	URET	CTAS pFAST TMA SC	CTAS pFAST	SMA

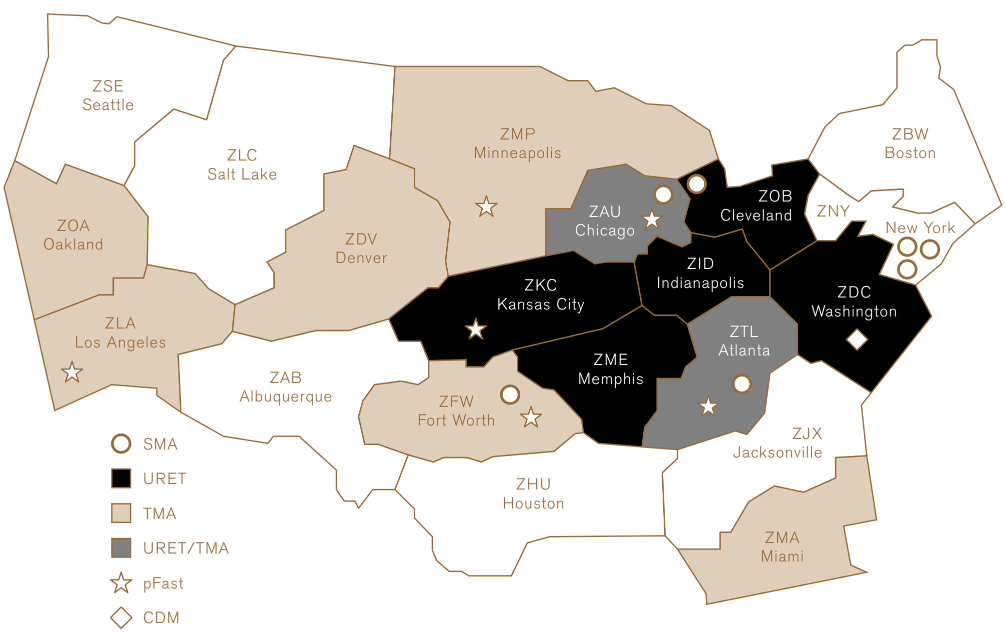
4.2 Free Flight Technology Operational Tests

Modernizing the NAS has inherent risks. Many of the technologies have not been operationally tested. To minimize these risks and to gain a better understanding of potential challenges, the FAA has developed two risk mitigation strategies: Free Flight Phase 1 and Safe Flight 21. These programs are intended to reduce technical and financial risks through the implementation of select technologies at specific sites for evaluation by NAS users and the FAA prior to full implementation.

4.2.1 Free Flight Phase 1

The Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD) initiative will deliver early benefits to NAS users and mitigate the risks associated with NAS modernization. This initiative will evaluate five low-risk technologies at a limited number of locations: the User Request Evaluation Tool, the Traffic Manager Advisor, the Passive Final Approach Spacing Tool, the Surface Movement Advisor, and Collaborative Decision Making. The sites of these deployments are shown in Figure 4-5. The results of the Core Capabilities Limited Deployment will be important in supporting further NAS modernization planning and funding. The initiative should be completed in 2002.

Figure 4-5: Free Flight Phase 1 Deployment Sites



SMA (at Airports)	**URET** (at ARTCCs)	**TMA** (at ARTCCs)	**pFAST** (at TRACONs)	**CDM**
Atlanta	Atlanta	**Atlanta**	Atlanta	**ATCSCC**
Chicago	Chicago	Chicago	Chicago	
Dallas/Ft. Worth	Cleveland	**Denver**	**Dallas/Ft. Worth**	
Detroit	**Indianapolis**	**Ft. Worth**	Los Angeles	
Newark	Kansas City	**Los Angeles**	Minneapolis	
Philadelphia	**Memphis**	**Miami**	St. Louis	
Teterboro	Washington	Minneapolis		
		Oakland		

Deployed Capabilities in Bold

4.2.2 Safe Flight 21

Safe Flight 21 is a five-year government and industry effort to demonstrate the capabilities of advanced communication, navigation, surveillance and air traffic procedures associated with free flight. Safe Flight 21 expects to validate the modernization effort and accelerate its progress, while minimizing the long-term risk and cost to the remainder of the NAS.

The Safe Flight 21 initiative will focus primarily on developing avionics technology, pilot procedures for surveillance of other aircraft, and developing a suitable ADS system for ATC. The Safe Flight 21 initiative takes place in two sites: the Ohio Valley and western Alaska. A common design will be used for the two project sites to facilitate the collection and analysis of data.

4.2.2.1 Ohio Valley Project

The Ohio Valley Project is co-sponsored by the FAA and the Cargo Airline Association to demonstrate ADS-B aircraft detection, conflict detection, alerts, resolution advisories, and evasive maneuver capabilities. Also to be demonstrated is the use of GPS LAAS avionics and the CDTI moving map display in helping pilots taxi on the airport surface during reduced visibility.

The first demonstration took place in July 1999, using 24 airplanes. Air cargo carriers, FAA, NASA, military, and academia participated in this initial evaluation. During the demonstration, ADS-B positional data was fused with radar data and displayed on an air traffic workstation. A complete analysis of this demonstration will be conducted later in 1999. Operational evaluations will continue through 2002.

4.2.2.2 Alaska Capstone Project

The Alaska Capstone project, which began early in 1999, will focus on aviation services, flight rules, and weather observations available to pilots. Although the primary objective of Capstone is to improve safety by increasing the pilot's situational awareness of the flight environment, an additional objective is to demonstrate the efficiency and cost effectiveness of specific Free Flight technologies. Capstone will develop the initial procedures, test avionics, and deploy ground systems supporting the technologies to be tested.

Demonstrations will take place in western Alaska in a non-radar environment. Nearly 200 commercially operated aircraft will voluntarily equip with government-furnished, GPS-based avionics and datalink communication suites, which include FIS and ADS-B. GPS non-precision instrument approach procedures will be developed and published for runways at 10 remote village airports in the test area. Integrated ADS data and radar data will be studied to determine if aircraft separation standards can be reduced. FIS will be evaluated for its use in providing real-time, graphically-displayed weather and other information to the cockpit.

The first operational demonstration took place in August 1999. This demonstration showed that the GPS avionics, multifunction displays and datalink systems meet FAA performance specifications. Additional demonstrations will continue through 2002.

CHAPTER 5: AIRPORT DEVELOPMENT

5 Airport Developments

Faced with steadily growing traffic, the FAA, airport operators, and NAS users are working together to increase system capacity. Adding to the nation's airport infrastructure is the most direct means of enhancing capacity. But because airport development projects can take a decade or more from planning through completion, and are usually very expensive, it is also important to look for ways to use the existing infrastructure more efficiently. Improvements in efficiency can usually be implemented in a shorter time frame, are less expensive, and have an immediate impact.

This chapter describes the current airport system, sources of funds for airport development, ongoing airport construction and expansion projects, and airport capacity studies conducted by the Office of System Capacity.

5.1 Airport Capacity in the United States

Although there are more than 18,000 public-use airports in the United States, the FAA considers only 3,300 to be significant to the capacity of the national airspace system. These airports are included in the National Plan of Integrated Airport Systems (NPIAS) and are thereby eligible to receive Federal grants under the Airport Improvement Program (AIP). Within the NPIAS, airports are divided into several categories, based on each airport's annual passenger enplanements, as shown in Figure 5-1. Airports with at least 2,500 annual enplanements are classified as commercial service airports, while those with fewer annual enplanements are classified as general aviation airports. Commercial service airports with more than 10,000 annual enplanements are considered primary airports, which are further divided into non-hub, small-hub, medium-hub and large-hub airports. The 30 large-hub airports accounted for 69 percent of all passenger enplanements in 1998. Delays are most prevalent at, but not limited to, these airports.

Figure 5-1: Distribution of Aviation Activity at U.S. Airports

Type of Airport	Number of Airports	Definition by % of Enplanements	% of All Enplanements	% of Active GA Aircraft
Primary				
Large-Hub	30	> 1%	68.8%	1.3%
Medium-Hub	38	.25%–1%	19.9%	3.8%
Small-Hub	73	.05%–.24%	7.8%	4.7%
Non-Hub	275	< .05%	3.3%	11.4%
Total Primary	416	> 10,000 EPs	99.9%	21.2%
Non-Hub, Non-Primary	130	2,500–10,000 EPs	0.1%	2.1%
Commercial Service	546		100.0%	23.3%
General Aviation				
Reliever	334			31.5%
General Aviation*	2,490	< 2,500 EPs		37.3%
General Aviation	2,824			68.8%
Total NPIAS**	3,370			92.1%
Non-NPIAS	14,630			7.9%
Total Airports	18,000			100.0%

** General aviation airports have at least 10 based aircraft*

*** Total NPIAS airports are the sum of commercial service plus general aviation airports*

The capacity of an individual airport is the number of operations (take-offs and landings) that can be safely performed in a given period of time. However, actual capacity is difficult to measure precisely, because it varies with runway configuration, winds, and other weather conditions. Figure 5-2 lists actual hourly departure and arrival rates, extracted from ETMS, at large-hub airports. DFW has the highest actual arrival and departure rates in the country, followed by ATL and ORD. If scheduled arrivals and departures exceed the level that can be efficiently handled, it is reasonable to expect delays.

Figure 5-2: Hourly Arrival and Departure Rates at Large Hub Airports, CY1998

Airport	ID	Departures	Arrivals	Total Operations
Hartsfield Atlanta International	ATL	94	93	180
Boston Logan International	BOS	60	58	110
Baltimore-Washington International	BWI	36	35	60
Charlotte-Douglas International	CLT	57	53	101
Greater Cincinnati International	CVG	71	62	123
Ronald Reagan National	DCA	39	39	69
Denver International	DEN	59	63	108
Dallas-Fort Worth International	DFW	99	109	197
Detroit Metropolitan County	DTW	68	69	126
Newark International	EWR	54	52	94
George Bush Intercontinental	IAH	55	60	110
New York John F. Kennedy International	JFK	44	53	77
Las Vegas McCarran International	LAS	38	39	72
Los Angeles International	LAX	81	79	138
New York LaGuardia	LGA	41	41	77
Orlando International	MCO	39	43	72
Miami International	MIA	62	62	111
Minneapolis-St. Paul International	MSP	64	63	109
Chicago O'Hare International	ORD	94	99	180
Philadelphia International	PHL	56	62	99
Phoenix Sky Harbor International	PHX	50	52	94
Greater Pittsburgh International	PIT	70	68	115
San Diego International Lindbergh Field	SAN	28	26	47
Seattle-Tacoma International	SEA	47	49	81
San Francisco International	SFO	51	51	86
Salt Lake City International	SLC	43	53	78
Lambert-St. Louis International	STL	62	63	112
Tampa International	TPA	35	31	53

Excludes Honolulu (HNL) and Washington Dulles (IAD)

Total operations in this figure are less than the sum of hourly arrival and departure rates. The difference results from implementation of various runway usage configurations, some which allow more arrivals, others which allow more departures, while total operations reflect the number of arrivals and departures that can be handled simultaneously.

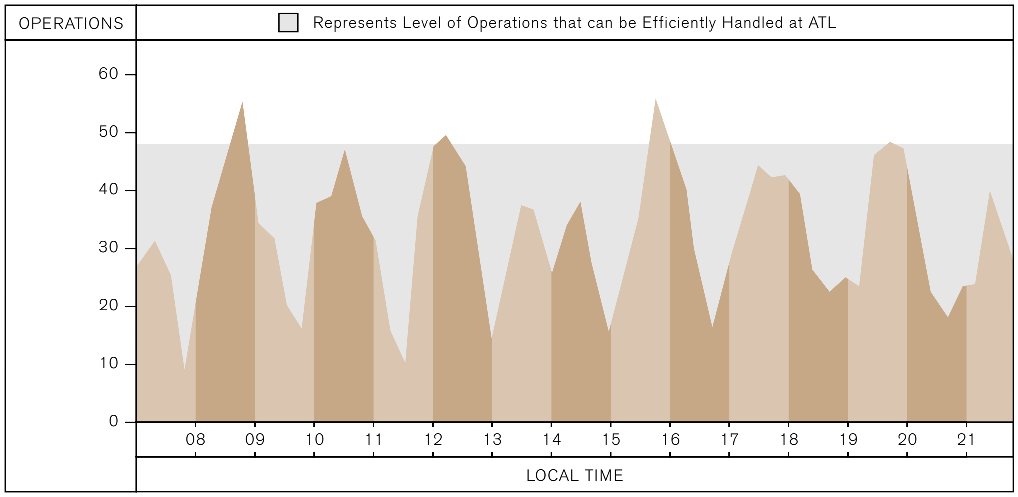
For the large hub airports, ETMS is 89.4% of official traffic counts. The major reason for this difference is that ETMS does not capture any general aviation VFR traffic. Therefore, these percentile values may slightly understate actual rates.

Arrival and departure rates from 0700 to 2159 local time.

Source: Enhanced Traffic Management System (ETMS)

Over a day, the number of scheduled operations at an airport in a given period of time can vary tremendously. As an illustration, during 1998 the number of scheduled operations at ATL varied from approximately 10 to 55 per quarter hour, as shown in Figure 5-3.

Figure 5-3: Scheduled Operations, by Quarter Hour, at Atlanta Hartsfield International Airport, CY1998



As an illustration, ATL could efficiently perform 48 operations (take-offs and landings) per quarter hour at the 95th percentile. As a result, it is reasonable to expect delays since there are certain times during the day when scheduled operations exceed the level that can be safely handled.

For the large hub airports, ETMS is 89.4% of official traffic counts. The major reason for this difference is that ETMS does not capture any general aviation VFR traffic. Therefore, these percentile values may slightly understate actual rates.

Arrival and departure rates from 0700 to 2159 local time.

Source: Enhanced Traffic Management System (ETMS)

5.2 Funding of Airport Capital Development

Airport capital development is funded by a combination of public and private sources: tax exempt bonds, AIP grants, passenger facility charges (PFCs), state and local grants, and airport revenue. The FAA administers AIP grants and oversees the collection and use of PFCs by individual airports.

5.2.1 Airport Improvement Program Grants

AIP grants are intended primarily to: promote safety and security; stimulate capacity-enhancement projects such as the construction of runways, taxiways, and aprons; help finance small and general aviation airports; and pay a significant part of noise and environmental mitigation cost. Terminal development projects, such as expanding commercial space and parking garages and paying interest on debt, are typically not eligible for AIP grants.

In 1998, the FAA funded 1,040 AIP grants for a total of $1.5 billion. Primary airports received 69 percent of the AIP funds (see Figure 5-4).[11]

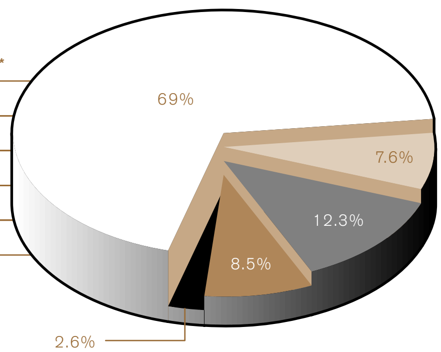
11 Airport Improvement Program, Fiscal Year 1998: Number of Grants Awarded and Total Amounts.

Figure 5-4: Distribution of AIP Grants by Type, CY1998

AIRPORT TYPE	NUMBER OF GRANTS	GRANT AMOUNT*
Primary	503	$1,036.8
Other Commercial	48	$39.1
Reliever	122	$127.8
General Aviation	304	$185.5
Other **	63	$114.3
TOTAL	**1,040**	**$1,503.5**

** Dollars in Millions*

*** State block grants and system plans*



5.2.2 Passenger Facility Charges

Since the early 1990s, commercial service airports have been permitted to charge passengers a boarding fee, called a passenger facility charge, to help pay for airport capital development projects. Airports may impose a PFC of up to $3 per flight segment, limited to two fees per one-way trip, or four fees on a round trip, bringing the maximum per ticket charge to $12.

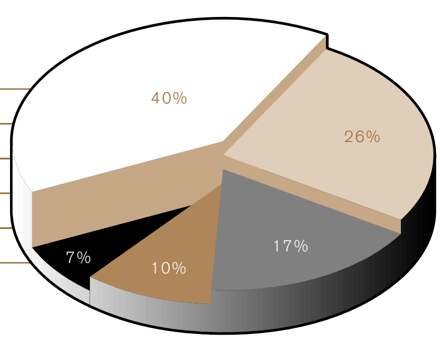
The 1990 statute creating the PFC program permits a variety of uses, including preserving or enhancing airports' safety, security, or capacity; reducing airport noise; and enhancing airline competition. Airports must apply to the FAA for approval to collect PFCs, on a project-specific basis. As of October 1999, the FAA has approved the collection, over a period of years, of approximately $24.1 billion in PFCs, as shown in Figure 5-5. Actual collections in CY1998 were approximately $1.4 billion.

A recent General Accounting Office (GAO) report concluded that the PFC program is making a significant contribution to airport development. Based on 1996 data, GAO found that PFCs provided about 18 percent of the funds available to commercial service airports. While 52 percent of eligible airports are collecting PFCs, almost 80 percent are large- and medium-hub airports.

Congress is currently considering a number of changes in the PFC program. These include raising the maximum per-segment fee from the present $3, changing the types of projects eligible for funding, and establishing new criteria for the selection of specific projects.

Figure 5-5: Approved Passenger Facility Charges

	FUNDS (In Billions)
Aircraft Gates and Access Roads	$9.8
Interest on Bonds for Eligible Development Projects	$6.2
Runways and Aprons	$4.2
Denver International	$2.3
Noise	$1.6



5.3 Airport Construction and Expansion

Clearly, building new airports can increase aviation system capacity. But the FAA also considers other possible solutions to meeting growing traffic demand, including the conversion of military airfields to civilian use, the joint use of existing military facilities, and the expanded use of existing but under-utilized airports. Finally, expanding existing airports is an important part of capacity enhancement.

5.3.1 Construction of New Airports

The construction of new airports provides the largest and most obvious increase in aviation system capacity. However, given the high cost of construction and the large land use and environmental impact of an airport, few have been built in recent decades. Denver International was completed in 1995 and before that Dallas-Fort Worth International was completed in 1974.

5.3.2 Conversion of Military Airfields to Civilian Airport Facilities

The Military Airport Program (MAP), funded by an AIP set aside of four percent, provides grants to current or former military airports with the potential to improve the capacity of the NAS. Airports remain eligible to participate in the MAP for five fiscal years following their initial designation as participants. There were nine MAP participants in 1998: five reliever airports, three primary commercial service airports, and one commercial service airport.

Figure 5-6: 1998 Participants in the Military Airport Program

Civilian Name	**Military Name**	**Location**	**Airport Type**
San Bernardino International	Norton AFB	San Bernardino, CA	Reliever
Alexandria International	England AFB	Alexandria, LA	Primary
Austin-Bergstrom International	Bergstrom AFB	Austin, TX	Primary
Williams Gateway	Williams AFB	Chandler, AZ	Reliever
Rickenbacker	Rickenbacker AFB	Columbus, OH	Reliever
Myrtle Beach International	Myrtle Beach AFB	Myrtle Beach, SC	Primary
Homestead Regional	Homestead AFB	Homestead, FL	Reliever
Sawyer	K.I. Sawyer AFB	Marquette, MI	Commercial Service
Millington Municipal	Memphis NAS	Millington, TN	Reliever

The most significant MAP project to date has been the conversion of Bergstrom Air Force Base into a civilian airport for the capital of Texas. The new airport, called Austin-Bergstrom International Airport, has terminal and air cargo facilities three times as large as those at the former Robert Mueller Airport. Austin-Bergstrom has two runways spaced one mile apart, which will allow independent parallel approaches in IFR conditions. The 12,250-foot east runway, which includes the existing main runway from the Air Force Base, has been in use by cargo operations since June 1997. The new 9,000-foot west runway was recently completed. The conversion had a total project cost of $690 million.

The airport opened for passenger operations on May 23, 1999, with the dedication of the Barbara Jordan Passenger Terminal. The Robert Mueller Airport closed down one month after the opening of Austin-Bergstrom International Airport.

Figure 5-7: Austin Airport—Past and Present

Austin Mueller Municipal Airport 1960-1969 dedication, Lyndon Johnson–speaker; Austin Municipal Airport Terminal October 26, 1938; and artist rendering of the new Barbara Jordan Passenger Terminal from the west end.

5.3.3 Construction of New Runways, Extensions, Taxiways, and Aprons

As environmental, financial, and other constraints continue to restrict the development of new airports, increased emphasis has been placed on the redevelopment and expansion of existing airport facilities. The construction of new runways and the extension of existing runways is the most direct action to improve capacity at existing airports. Large capacity increases under both visual flight rules and instrument flight rules result from the addition of new runways. In addition, if the runway is carefully placed, the airport will be able to conduct independent arrival/departure streams.

Although runways have the most noticeable impact on airfield capacity, other construction projects both complement new and extended runways or improve the use of existing capacity. These projects include new and extended taxiways, aprons, holding pads, and other projects that largely affect circulation of aircraft on the airport surface.

At least partly because of the effective moratorium on the construction of new airports, most large airports are planning or building new runways or runway extensions and a number have completed such projects in the last few years. Figure 5-8 lists new runways and runway extensions that have been completed from 1995 to 1999.

Figure 5-8: Runway Improvements Completed from 1995 to 1999

		Runway Improvement						
ID	**Airport**	**New**	**Ext**	**Renov**	**Recon**	**Realign**	**Year**	**Runway**
ABQ	Albuquerque Intl				●		1995	8/26
ANC	Anchorage Intl		●				1996	32
AUS	Austin-Bergstrom Intl			●			1999	17R/35L
BOI	Boise Air Terminal		●				1997	10L/28R
CMH	Port Columbus Intl		●				1997	10L
CMH	Port Columbus Intl		●				1996	28R
CVG	Greater Cincinnati/Northern Kentucky		●				1995	18R/36L
DFW	Dallas-Ft. Worth Intl	●					1996	17L/35R
GRR	Grand Rapids Kent County Intl		●				1997	18/36
GRR	Grand Rapids Kent County Intl					●	1998	17/35
GSP	Greenville-Spartanburg		●				1999	3L/21R
IND	Indianapolis Intl	●					1997	5L/23R
LAS	Las Vegas McCarran Intl				●		1997	1L/19R
LIT	Little Rock Adams Field		●				1998	4L/22R
MDW	Chicago Midway				●		1997	4R/22L
MEM	Memphis Intl	●					1998	18L/36R
MKE	Milwaukee General Mitchell Intl					●	1996	7L/25R
MKE	Milwaukee General Mitchell Intl		●				1998	7L/25R
MSN	Madison/Dane County Regional	●					1998	3/21
MSP	Minneapolis-St. Paul Intl		●				1996	4/22
OMA	Omaha Eppley Airfield		●				1996	14R/32L
PHL	Philadelphia Intl	●					1999	8/26
PSP	Palm Springs Regional		●				1998	31L/13R
SDF	Louisville Intl-Staniford Field	●					1997	17R/35R
SLC	Salt Lake City Intl	●					1995	16R/34L
Total		**7**	**12**	**1**	**3**	**2**		

Figure 5-9 shows that 9 of the 15 large-hub airports considered congested in 1998 are planning or building new runways or runway extensions. Of the 21 large-hub airports expected to be congested in 2008, 14 have runway improvements planned or underway. Overall, 63 of the busiest 100 airports are planning or building new runways or runway extensions. Appendix C contains airport diagrams of the busiest 100 airports.

Figure 5-9: Runways–Planned, Proposed, or Currently Under Construction–at the 100 Busiest Airports

ID	Airport	5 min Delay-1998	5 min Delay-2008	New	Extension	Reconstruction	R/W Identifier	Estimate Cost ($M)	Planned Operational Year	In Progress
ABQ	Albuquerque Intl				●		12/30	$ 14.0	2000	●
ALB	Albany County				●		10/28	$ 5.8	2000	
					●		1/19	$ 7.5	2005	
ATL	Hartsfield Atlanta Intl	●	●	●			9S/27S	$ 450.0	2004	
BHM	Birmingham				●		5/23	$ 17.0	2002	
BNA	Nashville Intl			●			2E/20E	TBD	TBD	
					●		2R/20L	TBD	TBD	
BOI	Boise Air Terminal			●			10R/28L	TBD	2015	
BOS	Boston Logan Intl	●	●	●			14/32	$ 50.0	2003	
BUF	Greater Buffalo Intl				●		14/32	$ 4.9	2005	
BWI	Baltimore-Washington Intl			●			10R/28L	$ 150.0	2008	
CLE	Cleveland-Hopkins Intl			●			5W/23W	$ 467.0	2002	
					●		5R/23L	$ 40.0	2005	
CLT	Charlotte/Douglas Intl		●	●			18W/36W	$ 140.0	2002	
					●		18R/36L	$ 22.0	2006+	
CMH	Port Columbus Intl			●			10S/28S	$ 100.0	2020	
CVG	Greater Cincinnati/Northern Kentucky Intl	●	●	●			18R/36L	$ 233.0	2004	
					●		9/27	$ 12.0	2003	
DAY	Dayton Intl				●		6R/24L	TBD	2002	
					●		6L/24R	TBD	TBD	
DEN	Denver Intl			●			16R/34L	$ 160.0	2004	
DFW	Dallas/Fort Worth Intl	●	●		●		18L/36R	$ 48.0	2001	
					●		18R/36L	$ 19.0	2003	
				●			18R/36L	$ 367.3	2005	
					●		17C/35C	$ 25.0	2002	
DSM	Des Moines Intl				●		5/23	$ 31.0	2001	●
DTW	Detroit Metropolitan Wayne County	●	●	●			4/22	$ 116.5	2001	●
ELP	El Paso Intl				●		4/22	$ 8.0	2000	
EWR	Newark Intl	●	●		●		4L/22R	$ 55.0	2000	●
FLL	Fort Lauderdale-Hollywood Intl				●		9R/27L	$ 300.0	2005	
GEG	Spokane Intl			●			3L/21R	TBD	TBD	
GRR	Grand Rapids Kent County Intl			●			8L/26R	TBD	2020	
GSO	Greensboro Piedmont Triad Intl			●			5L/23R	$ 96.0	2004	
GSP	Greer Greenville-Spartanburg			●			3R/21L	$ 65.0	2010	
IAD	Washington Dulles Intl			●			1W/19W	$ 200.0	2008	
				●			12R/30L	$ 200.0	2002	
IAH	George Bush Intercontinental	●	●		●		15R/33L	$ 85.0	2000	
				●			8L/26R	$ 130.0	2002	
				●			9R/27L	TBD	TBD	
ICT	Wichita Mid-Continent				●		1R/19L	TBD	TBD	
IND	Indianapolis Intl			●			5R/23L	$ 80.0	2008	
ITO	Hilo Intl				●		8/26	$ 25.0	2010	
JAX	Jacksonville Intl			●			7R/25L	$ 50.0	2011	
LBB	Lubbock Intl				●		8/26	$ 15.0	2005	
MCI	Kansas City Intl				●		1L/19R	$ 12.0	TBD	
MCO	Orlando Intl			●			17L/35R	$ 115.0	2002	

Figure 5-9 *continued*

ID	Airport	5 min Delay-1998	5 min Delay-2008	New	Extension	Reconstruction	R/W Identifier	Estimate Cost ($M)	Planned Operational Year	In Progress
MCO	Orlando Intl				●		17R/35L	TBD	TBD	
MEM	Memphis Intl				●	●	18C/36C	$ 103.0	2000	●
					●		18R/36L	TBD	TBD	
MIA	Miami Intl		●	●			8/26	$ 206.0	2002	
MKE	Milwaukee General Mitchell Intl			●			7/25	$ 160.0	2015	
MSP	Minneapolis-St Paul Intl	●	●	●			17/35	$ 490.0	2003	●
					●		4/22	$ 7.0	2001	
MSY	New Orleans Intl			●			18/36	$ 400.0	2010	
OGG	Kahului				●		2/20	$ 47.0	2001	
OKC	Oklahoma City Will Rogers World				●		17R/35L	$ 8.0	2014	
					●		17L/35R	$ 8.0	2014	
				●			17/35	$ 13.0	2012	
					●		13/31	$ 11.2	2010	
OMA	Omaha Eppley Airfield				●		14L/32R	TBD	TBD	
ORF	Norfolk Intl			●			5R/23L	$ 100.0	2005	
PBI	Palm Beach Intl				●		9L/27R	$ 9.0	2000	●
PHX	Phoenix Sky Harbor Intl		●	●			7/25	$ 180.4	2000	●
					●		8L/26R	$ 7.0	2002	
PIT	Greater Pittsburgh Intl		●	●			10/28	$ 150.0	2006	
PNS	Pensacola Regional				●		8/26	$ 12.3	2002	
RDU	Raleigh-Durham Intl			●			5W/23W	TBD	TBD	
					●		5R/23L	TBD	2005+	
RIC	Richmond Intl				●		16/34	$ 45.0	2001	
RSW	Fort Myers Southwest Florida Regional			●			6R/24L	$ 80.0	2010	
SAT	San Antonio Intl				●	●	12L/30R	$ 43.0	2004	
				●			12N/30N	$ 400.0	2020+	
SAV	Savannah Intl			●			9L/27R	$ 20.0	2020	
SEA	Seattle-Tacoma Intl		●	●			16W/34W	$ 750.0	2006	●
SJC	San Jose Intl				●		12L/30R	$ 54.3	2001	●
SMF	Sacramento Intl				●		16R/34L	TBD	TBD	
					●		16L/34R	TBD	TBD	
SNA	John Wayne-Orange County				●		1L/19R	TBD	TBD	
SRQ	Sarasota-Bradenton			●			14L/32R	$ 10.0	2004+	
					●		14/32	$ 5.1	2002	
STL	Lambert St. Louis Intl	●	●	●			12/30	$ 850.0	2004	
					●		12R/30L	$ 50.0	TBD	
SYR	Syracuse Hancock Intl			●			10L/28R	$ 55.0	TBD	
					●		10R/28L	TBD	TBD	
TPA	Tampa Intl			●			17/35	TBD	2012	
					●		9/27	TBD	2020+	
					●		18L/36R	TBD	2020+	
TUL	Tulsa Intl			●			18/36	$ 115.0	2010	
TUS	Tucson Intl			●			11R/29L	$ 30.0	2005+	
TYS	Knoxville McGhee-Tyson				●		5L/23R	$ 7.0	2004	
					●		5R/23L	TBD	TBD	
Totals				**42**	**49**	**2**				**10**

5.3.4 Airport Enhancements for New Large Aircraft

Airbus and Boeing are both considering developing a new large aircraft (NLA) with seating capacities exceeding 600 passengers. Airbus' proposed NLA design will conform with the 80-meter maximum fuselage length and wingspan limitation at several major international airports and the runway length required for take-off or landing will be no more than that needed by a 747-400.

A substantial number of existing U.S. large-hub airports were designed for the requirements of early versions of the B-747 and even smaller aircraft. These airports, with 75-foot wide taxiways, and separations and clearances between parallel taxiways and runways that reflect operational requirements for aircraft with wingspans less than 65 meters, are referred to as design Group V airports.

The FAA is concerned about NLA operations and has formed a working group to address NLA operating requirements. The NLA Facilitation Group is attempting to determine the NLA minimum operating requirements to assess whether the NLA can be introduced to design Group V airports. Relevant issues include the effects of the landing gear on pavement, the effects of engine thrust on other operations and the airport environment, the size of the required obstacle free zone (OFZ), and taxiway deviations. Computer simulations of the impact of a balked landing of an NLA on the definition of the OFZ are promising and indicate that when autopilot is in use for a balked landing, the existing OFZ at Group V airports is sufficient to safely handle NLA. A study underway at JFK International Airport is assessing the deviations from centerline by taxiing B-747 wide-bodied aircraft over a range of speeds and weather conditions. The data will be used to determine the degree of risk associated with NLA deviations on the airport surface.

5.4 Airport Capacity Studies

The FAA has also been placing increased emphasis on maximizing the capacity at existing airports through improvements in runways and taxiways, navigational and guidance aids, and operational procedures. The Office of System Capacity coordinates research on such improvements conducted by Airport Capacity Design Teams, Tactical Initiative Teams and Regional Design Teams.

5.4.1 Airport Capacity Design Team Studies and Assessments

Airport Capacity Design Teams evaluate capacity problems at airports that already are experiencing significant flight delays. A typical Design Team includes FAA representatives from ASC, Air Traffic, the Technical Center and the appropriate region, and representatives from the airport operator, airlines, and other aviation interests.

Design Team members propose actions that they feel will improve airport capacity. After an initial review, promising alternatives are selected for more detailed analysis. The Technical Center's NAS Advanced Concepts Branch conducts computer simulations of these proposed actions. The output of the simulation is an analysis of the impact of that alternative on the operation of the airport.

Upon completion of its study, the Airport Capacity Design Team will issue a Capacity Enhancement Plan (CEP) that presents a list of recommended actions and estimates of the impact of each alternative on delays at that airport. The recommendations require additional study before they can be implemented, but over the years, a large number of Design Team recommendations have been adopted by the airport operators, funded by the FAA, and implemented.

Since the start of the program in 1985, 44 Airport Capacity Design Team studies have been completed and CEPs published. Appendix B lists completed CEPs, their recommendations, and the status of those recommendations (whether they were or were not implemented). Studies of Newark International and Tampa International airports, which were completed in 1999, are summarized briefly below. ASC recently began conducting recommendation assessment studies to evaluate the accuracy of the benefits of the recommendations of completed Capacity Enhancement Plans. The first assessment study, of a Salt Lake City International Airport Capacity Enhancement Plan, was published in April 1999 and is discussed below.

5.4.1.1 Newark International Airport

The Newark International Airport (EWR) Airport Capacity Design Team completed its study of capacity enhancements this year. The study was undertaken in 1996 when it became clear that attempts to increase flight schedules resulted in sharp increases in delays, indicating that the airport was congested and that demand was beyond the knee of the demand curve. Indeed, in 1996 and subsequent years, EWR has had the highest number of delays per 100,000 operations, as well as the highest average delay per operation, of any U.S airport.

The Design Team evaluated capacity enhancement alternatives at three levels of traffic demand: a baseline of 454,000 operations, representing actual 1996 traffic levels, and two levels of future demand, Future 1 at 500,000 operations and Future 2 at 550,000 operations. The Design Team also estimated the annual hours of delay at each level of demand if no capacity enhancements were adopted. That analysis showed that the 10 percent growth in traffic from the baseline to Future 1 would result in a disproportionate increase in delays of 205 percent. The analysis calculated that the further 10 percent increase in traffic to Future 2 would produce an additional 208 percent increase in delays. Consequently, nearly all of the alternatives were not simulated at the Future 2 demand level.

The capacity enhancement alternatives consisted of airfield improvements, operational improvements, and user or policy improvements. Among the alternatives evaluated were a number of new approach procedures and the use of immediate divergent turns for turboprops and propeller aircraft. The alternatives were modeled at the FAA Technical Center. Delay savings were calculated as the difference between what the model showed at each of the three demand levels with no improvements and the estimated delays with that individual improvement. The delay savings were valued at the direct operating costs of the airlines serving EWR.

The purpose of the study was to determine the technical merits of each alternative and its impact on capacity. Additional studies will be required to assess airspace, environmental, socioeconomic, or political issues associated with these actions. Since all of the capacity enhancement alternatives produced delay savings, the Design Team recommended that each of the alternatives be further studied to determine whether it should be undertaken. All initiatives will move on to the next step in the planning process.

5.4.1.2 Tampa International Airport

The Tampa International Airport (TPA) Capacity Design Team completed its study of delays and traffic demand this year. The study was conducted in conjunction with the airport's master plan update. The Design Team was formed in late 1997 in response to the rapid growth of traffic at TPA. Although TPA is not currently one of the most congested airports, traffic is projected to increase steadily, with delays accompanying that growth. The Design Team modeled capacity enhancement alternatives at three levels of traffic demand: a baseline of 250,000 operations, representing actual 1997 traffic, and future levels of 354,000 and 409,000. The future demand levels were based on the Design Team's consensus of potential traffic.

The Design Team limited its analysis to aircraft activity inside the final approach fix and on the airfield. The capacity enhancement alternatives consisted of airfield improvements, facilities and equipment improvements, and operational improvements. The Design Team evaluated 16 alternatives. The analysis showed that the greatest savings in delays would be provided by the following alternatives:

- Build a new precision Runway 17/35 located 700 feet west of existing Runway 18R/36L, to be used primarily for arrivals. Current noise restrictions on Runway 18R/36L would be maintained.
- Permit independent precision approaches to Runways 18L and 18R, and to Runways 36R and 36L. Both of these operational improvements would require a new radar monitor position. Runway 36R would also require either a glideslope or a precision GPS approach.

The Design Team recommended implementing these capacity enhancement improvements, as well as a number of the other alternatives, some immediately and others as traffic grows. They also referred four alternatives, including two runway extensions and two new approaches, for further study.

5.4.1.3 Salt Lake City International Airport Recommendation Assessment Study

A Salt Lake City International Airport (SLC) Capacity Design Team was formed in 1988 and published a Capacity Enhancement Plan in March 1991. The Design Team's major recommendation was for the airport to construct a parallel runway, with independent IFR capability, to the west of Runway 16R/34L. That recommendation was accepted. The new runway was built and opened for operations on October 24, 1995. A Recommendation Assessment Study was conducted this year to evaluate the accuracy of the Design Team's forecast of delays.

The Recommendation Assessment Study compared the annual delays predicted in the 1991 SLC Capacity Enhancement Plan with actual delays in 1997 and 1998. The study showed that the delays predicted for 1997 were 1.87 percent lower than actual delays that year and that the delays predicted for 1998 were 4.6 percent higher than 1998's actual delays. These extremely accurate predictions confirmed the validity of the analytic techniques employed by the Design Team and demonstrate the value of their work. The SLC Recommendation Assessment Study was published in April 1999.

5.4.2 Tactical Initiative Team Studies

Tactical Initiative Teams focus on providing immediate relief to airports with chronic delays. Their recommendations emphasize procedural changes that can be implemented quickly and at limited cost. An ongoing tactical initiative is summarized below.

5.4.2.1 San Diego International Airport

The San Diego Tactical Initiative Team has been investigating the effect of another terminal, ground flow alternatives, and short-term improvements such as an additional terminal concourse, taxiway development, and remote aircraft parking as approved in the Immediate Action Plan. A Master Plan study, which will address capacity and growth issues of San Diego International-Lindbergh Field, is currently underway. Completion of the Master Plan study is expected in early 2000. Recommendations from the San Diego Tactical Initiative Team are expected to be complete in late 1999.

5.4.3 Regional Capacity Design Team Studies

Regional Capacity Design Teams analyze all the major airports in a metropolitan or regional system and model them in the same terminal airspace environment. This regional perspective explores how capacity-producing improvements at one airport will affect air traffic operations at other airports and within associated airspace. Ongoing regional capacity studies are summarized below.

5.4.3.1 Northeastern Regional Capacity Design Study

Phase One of the Northeast Regional Study examined the capacity impacts of passenger migration from the primary airport Boston Logan International (BOS) to surrounding commercial passenger service airports. Phase Two will look at similar developments for the primary New York airports (EWR, JFK, LGA). Phase Three is a planned expansion of the study to the major Washington area airports (DCA, BWI, IAD). The Design Team is working with the Volpe National Transportation Systems Center on this effort.

5.4.3.2 Anchorage Area Design Team Study

The Anchorage Area Design Team Study includes Anchorage International (ANC), Lake Hood, Merrill Field, and Elmendorf AFB airports, as well as private-use airports and heliports in the Anchorage area. The Design Team is modeling multiple traffic streams from these airports with several alternatives and configurations. The study is assessing ways to relieve congestion problems caused by more than one million annual operations transiting over Point McKenzie. The study will also generate alternative approach procedures to the converging runway at ANC and to the closely spaced parallel runways. Analysis of approach procedures has determined the need for two IFR streams.

5.4.4 Additional Airport Capacity Activities

ASC also acts as a team member in other airport capacity projects. ASC is currently a participant on projects involving Dallas-Fort Worth International and Hartsfield Atlanta International Airports.

5.4.4.1 Dallas-Fort Worth International Airport

Dallas-Fort Worth International Airport (DFW) ranked first in U.S. airport operations in 1998, with 944,647 operations. Operations at DFW are expected to increase by 47.8 percent by 2013. DFW is also one of the airports that is now congested and is expected to have delays exceeding five minutes per operation in 2008, if no additional capacity improvements are made.

Additional capacity improvements being considered include new runways and taxiways. A new west runway, scheduled for construction when warranted by traffic demand, will allow the airport to support simultaneous quadruple parallel arrival streams. The placement of perimeter taxiways around the ends of the runways, to alleviate departure delays due to runway crossings, is being evaluated.

5.4.4.2 Hartsfield Atlanta International Airport

The Hartsfield Atlanta International Airport (ATL) Capacity Design Team recommended a commuter/general aviation runway complex in its March 1987 Airport Capacity Enhancement Plan. This concept was later modified to a 6,000-foot long fifth parallel commuter runway, 4,200 feet south of existing Runway 9R/27L. A December 1995 update of the Airport Capacity Enhancement Plan showed that this runway would provide significant delay savings benefits. Construction of the new commuter runway is under design and is expected to be completed in 2004. This runway will allow triple simultaneous arrivals to ATL in instrument conditions using the new Precision Runway Monitor technology. A runway dedicated to commuter aircraft arrivals will reduce airborne delay for those aircraft and air carrier aircraft operating on the four existing runways.

5.4.5 Air Traffic Control Ground Simulations

At the request of regional and local Air Traffic representatives, ASC has initiated ATC ground simulations at Las Vegas McCarran International Airport, Salt Lake City Airport, and Phoenix Sky Harbor International Airport. In addition, because of the FAA's recognized expertise in evaluating capacity enhancements, foreign airport operators have requested assistance. In 1999, the FAA conducted a ground simulation at Frankfurt International Airport, Germany.

The goal of these initiatives is to improve the operational efficiencies at these airports. These studies used the Technical Center's Airfield Delay Simulation Model (ADSIM) to analyze various airfield configurations and to determine daily total aircraft travel times and ground delays. The scope of these studies was limited to aircraft activity within the terminal airspace and on the airfield.

5.4.5.1 Las Vegas McCarran International Airport

A ground simulation study of Las Vegas McCarran International Airport (LAS) was initiated and completed in 1999. LAS recently added an additional gate complex, Terminal D. The objective of this study was to assess the effects of the expansion of Concourse D, the addition of the Future Charter/International Terminal, and expansion of Terminal 2 under alternative airfield and aircraft operational conditions. The conclusion of the analysis was that if no improvements are made, a 34 percent increase in traffic, referred to as the Future 2 Demand Level, will result in daily delays increasing by more than 60 percent. If all recommended improvements are made daily, delay times will remain at their current levels.

5.4.5.2 Salt Lake City International Airport

The Salt Lake City Analysis Team completed an aircraft ground movement analysis of Salt Lake City International Airport and published its report in April 1999. The team studied six different capacity enhancement alternatives and evaluated four future configurations. The study showed that annual savings of up to $11.23 million could be realized by rerouting aircraft to another runway when arrival delays exceed five minutes. The study also showed that the addition of the Category III ILS on Runway 34L would increase annual savings dramatically in the future. Overall, the most significant increase in savings will occur in Future Configuration 2005, when new terminals are operational and the old terminals have been removed.

5.4.5.3 Phoenix Sky Harbor International Airport

An initiative to assist Air Traffic with ground operations efficiency is being conducted at Phoenix Sky Harbor International Airport. The goal is to determine a more efficient use of runways for arrival and departure operations, based on both the present runway configuration and several alternate configurations during the construction of a third runway and the subsequent reconstruction of the existing runways. This initiative is expected to be completed in 2000.

5.4.5.4 Frankfurt International Airport

The FAA conducted a study at Frankfurt International Airport in Germany to determine the practical hourly capacity of the existing runway system and to investigate the potential capacity benefits of an additional runway or runway extensions. A target capacity of 120 aircraft movements per hour was developed and all scenarios were evaluated against this goal. The analysis team determined that an additional parallel runway, north of the existing runway system, would be the best means to attain the desired capacity. Additional simulated capacity studies will be needed to provide a detailed capacity comparison of the alternative scenarios.

CHAPTER 6:
AIRSPACE REDESIGN

6 Airspace Design

The previous chapter reported on the FAA's efforts to increase airport capacity and to use the existing airport infrastructure more efficiently. This chapter reports on the FAA's initiatives to increase airspace capacity by restructuring airspace and using existing airspace more effectively.

The FAA conducts airspace development studies to determine how to restructure airspace and modify arrival, departure, en route, and terminal flow patterns to streamline traffic flow. En route airspace studies may extend to one or more ARTCCs, encompassing traffic flowing into and out of several airports. Terminal airspace studies, undertaken to ensure that traffic patterns resulting from new runways, runway extensions, and traffic increases can be accommodated efficiently, usually encompass only about a 40-mile radius around the airport.

Airspace issues may be identified from within the FAA by air traffic controllers, or by external sources, such as airlines, airport authorities, or community groups. A request to examine an issue can arise from the perception that the airspace design contributes to traffic limitations, in-flight or ground delays, heavy controller workload, safety concerns, or excessive noise or other environmental concerns. Problems may also be identified as the result of planned changes to airports, equipment, or traffic patterns. The FAA continues to seek ways to improve the identification of potential airspace issues, and to resolve them before they become real problems. This chapter describes ongoing and recently completed en route and terminal airspace studies, the development of advanced area navigation routes and the potential impact of commercial satellite launches.

6.1 Restructuring Airspace

One of the key functions of airspace studies is determining where existing design no longer meets the demands of NAS users. Because air transportation is a dynamic industry, the FAA periodically adjusts airspace structure to meet changing traffic patterns. Several examples of restructuring airspace are discussed below.

6.1.1 Consolidating TRACONS

Consolidating existing Terminal Radar Approach Control facilities (TRACONS) into a single facility supports more efficient airspace design. Consolidated TRACONS will be able to enhance airspace capacity by improving communication among controllers handling aircraft over a wide geographic range and by increasing their flexibility in merging, maneuvering, and sequencing aircraft to and from airports. For example, many of the airspace changes made recently in the Los Angeles area were made possible by the construction of the consolidated Southern California TRACON. Figure 6-1 lists other planned consolidations.

Figure 6-1: Planned TRACON Consolidations

Consolidated TRACON	TRACONs Prior to Consolidation	
Atlanta	Atlanta	Macon
	Columbus	
Potomac	Andrews AFB	Baltimore
	Dulles	National
Northern California	Bay	Monterey
	Sacramento	Selected Oakland Center Sectors
	Stockton	
Suncoast TRACON (Central Florida)	Daytona Beach	Jacksonville
	Orlando	Tampa

Source: NAS Transition and Integration, Terminal Facilities Division (ANS-200)

6.1.2 Implementation of New Arrival Procedures at Los Angeles International

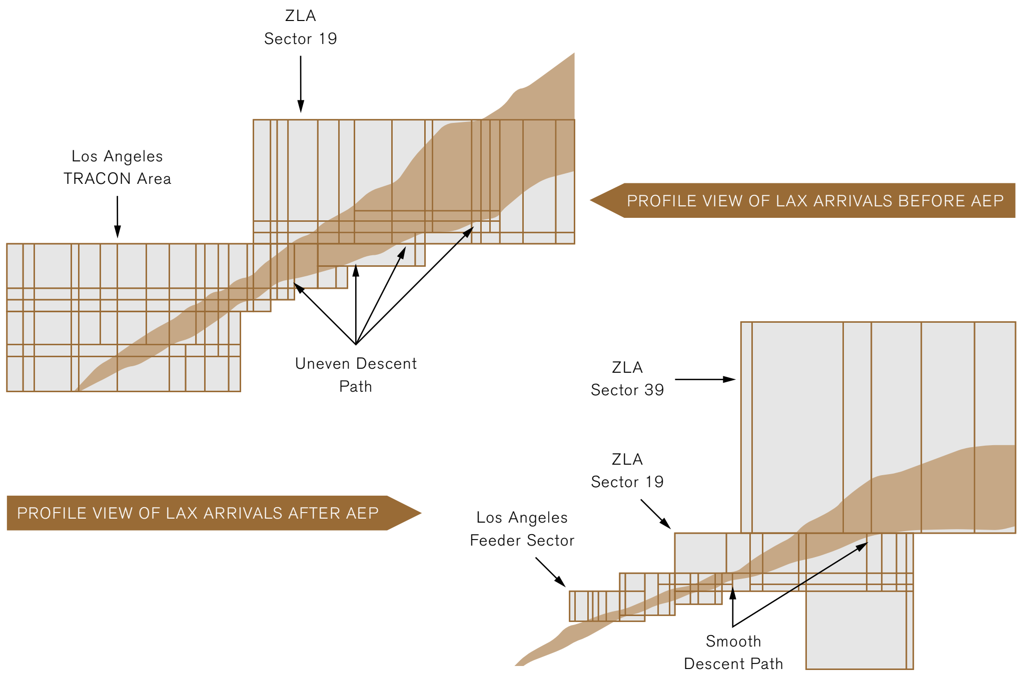
Arrival procedures to Los Angeles International Airport (LAX) were recently modified to take advantage of the new Southern California TRACON (SCT), which combined the operations of five TRACONS into a single facility (Burbank, Los Angeles, Ontario, Coast, and San Diego). The SCT now controls all airspace in the Los Angeles—San Diego area.

Previously, LAX arrivals from the east were funneled into the Los Angeles basin via an arrival procedure that merged airways into a single arrival stream. During peak arrival rushes, the arrival stream could not support the volume of traffic from the east. The traffic bottleneck caused by the single arrival stream frequently required ground stops and en route flow restrictions. In March 1998, an arrival enhancement procedure (AEP) for LAX was implemented, that provides dual arrival streams for flights landing at LAX from the east.

In addition, the LAX approach control area was expanded, allowing earlier use of airborne precision navigation and terminal separation criteria (three miles-in-trail), providing additional flexibility in maneuvering aircraft and making runway assignments. By delegating what had been en route airspace to the SCT-LAX feeder sector, traffic could be sequenced for approach using terminal procedures. As a result, ground delay programs have been virtually eliminated.

Another benefit of the new procedure is that it has eliminated frequent step-downs in LAX arrivals, resulting in safer, more efficient approaches with fewer pilot-controller interactions. Figure 6-2 illustrates the uneven descent paths that were typical before AEP, and the smoother descent paths for LAX arrivals afterwards. Initially, annual cost savings were estimated at $13.3 million. Shortly after implementing AEP, these estimates were revised upward to $14.6 million. Savings are expected to exceed $65 million annually by 2005. At the Reno ’98 FAA/Industry meeting, the Air Transport Association cited this procedure as the Air Traffic Control “Accomplishment of the Year.”

Figure 6-2: Descent Paths at Los Angeles International Airport



6.2 Airspace Studies

In mid-1998, the Office of System Capacity and the Air Traffic Airspace Management Program initiated a large-scale analysis of the national airspace structure, the National Airspace Redesign. They are also involved in en route and terminal airspace studies.

6.2.1 National Airspace Redesign

The goal of the National Airspace Redesign is to ensure that the design of airspace is consistent with the new requirements of free flight. The National Airspace Redesign will consist of incremental changes to the national airspace structure, consistent with evolving air traffic and avionics technologies. Environmental issues will be addressed as part of the redesign.

Phase 1 of the National Airspace Redesign was initiated in July 1998 and ranges from New York to Miami to Chicago, including air traffic facilities in the New England, Eastern, Great Lakes, and Southern Regions. Phase 2 will include the remaining FAA regions.

The study began by focusing on airspace problems in the New York and New Jersey area and traffic between New York and Washington, D.C. In May 1999, teams composed of FAA managers and air traffic controllers from affected facilities met to discuss airspace issues.

Numerous facilities have experienced high altitude sector overload, resulting in holds and other restrictions. Due to the complexity and volume of traffic in the New York area, miles-in-trail restrictions are applied almost daily at Newark and with increasing frequency at La Guardia. Congestion in Newark airspace frequently results in the imposition of miles-in-trail restrictions for Chicago departures and congestion throughout the New York area causes controllers to begin spacing out NY-bound aircraft up to 1,000 miles from their destination airports.

Airspace redesign in the New York area will take at least six years. An analysis of current operations in the New York area will be completed by the end of 1999 and the FAA expects to identify alternatives and begin environmental assessments by the end of 2000.

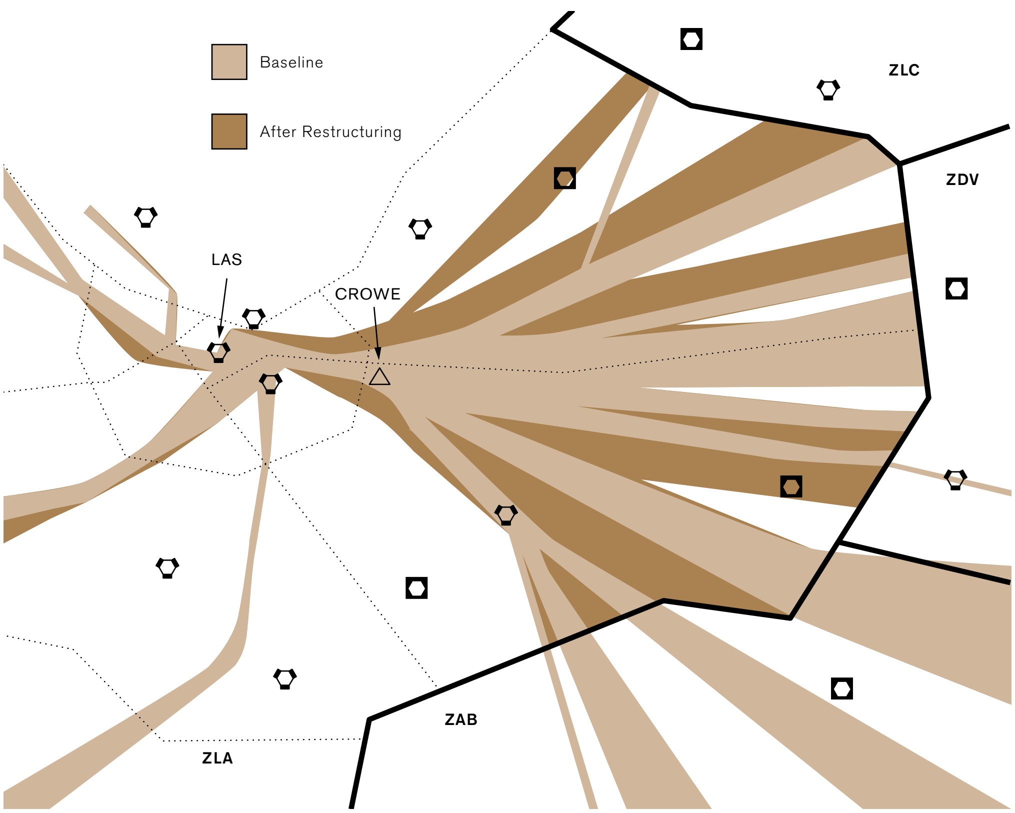
6.2.2 West Coast Airspace Analysis

ASC is involved in a large-scale analysis of airspace on the west coast, ranging from San Francisco/Oakland in the north to Los Angeles in the south and extending to Albuquerque to the east.

6.2.2.1 Las Vegas Airspace Restructuring

ASC and the Western-Pacific Region airspace project office conducted an airspace analysis of Las Vegas airspace. Because air traffic west of the airport is largely constrained by special use airspace, the analysis focused on routing alternatives to the east. In the past, one en route controller fed all traffic to the east over a single arrival fix, as shown in Figure 6-3. Based on the airspace analysis, the FAA developed a new structure for Las Vegas (LAS) arrivals and dedicated arrival and departure runways for the Runway 19/25 configuration, which is in use 90 percent of the time.

Figure 6-3: Las Vegas McCarran International Airport Airspace Prior to and after Restructuring



Proposed routing, sector geometry, and procedural changes for the restructuring primarily involved operations within the Los Angeles ARTCC and Las Vegas TRACON, with some routing modifications within the Salt Lake, Denver, and Albuquerque ARTCCs. Under the restructuring, arrivals to LAS will be routed to the corners, and departures down the middle to the east. As Figure 6-4 illustrates, implementation of the restructuring will require modification of sectors 07 and 08 and creation of a new sector 23.

Controllers working sector 23 will handle only departures, which will reduce the operations of sectors 07 and 08 by 40 percent. Sector 23 will work approximately 350 aircraft per day, with maximum 15-minute traffic counts of 10 or fewer aircraft at the baseline traffic demand level.

Partial implementation of the restructuring began in July 1998, involving primarily arrivals. The FAA expects that the restructuring will reduce arrival and departure delays. Preliminary estimates were that reduced delays, at baseline traffics levels, would be 9.1 hours per day, for annual cost savings of $5.2 million. These estimates are summarized in Figure 6-5.

Figure 6-4: Las Vegas Sector Modifications

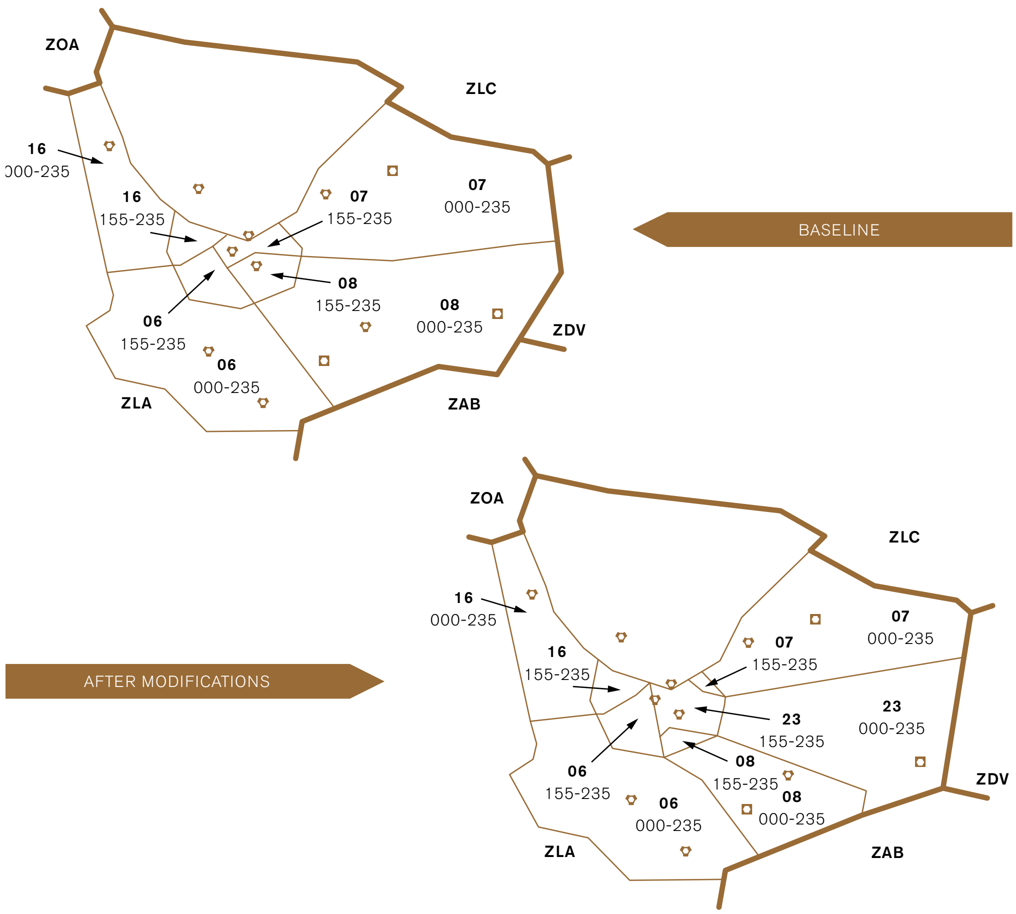


Figure 6-5: Cost Savings at Las Vegas McCarran International Airport from Airspace Restructuring

Traffic Demand Level	Change (In Hours): Daily Arrival Delay	Daily Arrival Travel Time	Daily Departure Delay	Daily Departure Travel Time	Total Daily Flight Time	Annual Operating Cost Change* ($ in millions)
Baseline	4.8	1.3	1.0	2.0	9.1	$5.2
Future 1	9.0	1.5	1.4	2.1	14.0	$8.0
Future 2	15.5	1.5	6.1	2.3	25.4	$14.5

** Based on marginal aircraft operating cost of $1600 per hour and VMC 98 per cent of time.*

6.2.2.2 Albuquerque Center

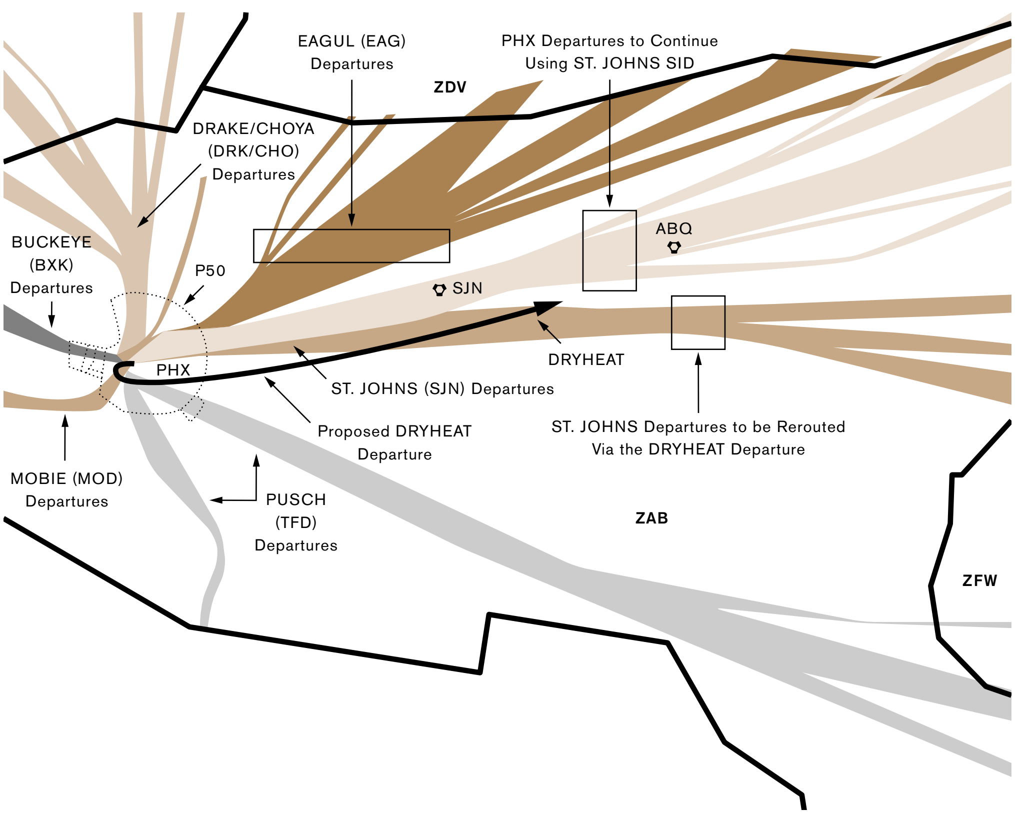
An airspace analysis of the Albuquerque ARTCC was initiated in May 1999. The study, a joint project between the Western-Pacific and Southwest regions, was initiated as the result of traffic flow problems in the western Albuquerque ARTCC. Miles-in-trail restrictions for departures from Phoenix limit traffic flow there, and as a result of the restructuring of Las Vegas airspace, arrival streams to Las Vegas must be established in the Albuquerque center's airspace. Addressing these issues will probably require resectorization of airspace. Data collection and model development are underway.

6.2.2.3 Phoenix Terminal Airspace–Dry Heat Procedure

In the fall of 1997, ASC and the Western-Pacific region initiated a terminal airspace study of departure delays at Phoenix Sky Harbor International Airport (PHX) and through Albuquerque airspace. Sixty percent of PHX departures from Runways 26L/R used DRAKE, EAGUL, or St. John's Standard Instrument Departures (SIDs) via a single stream to the north. During certain times of the day, the demand for the north departure stream resulted in significant delay.

To address this problem, the FAA developed the Dry Heat procedure, which uses a south departure stream during peak traffic periods. The Dry Heat procedure was implemented on February 25, 1999. Figure 6-6 shows departure traffic flows for PHX before the implementation of Dry Heat. This new procedure allows some departures using the St. John's SID to be routed to Dry Heat, resulting in better traffic volume balance across available fixes.

Figure 6-6: Departure Traffic Flows at Phoenix Sky Harbor International Airport



To evaluate the impact of the new procedure on capacity, the FAA collected performance data (such as scheduled and actual gate time, landing time, and airborne flight time) for PHX arrivals and departures for 20 days before and 29 days after the implementation of Dry Heat. The analysis of a specific airline showed an increase in traffic volume, improved taxi-time predictability, and reduced delays. Using Dry Heat resulted in an increase in the number of St. John's and Dry Heat departures of 7.6 flights per day. Before the airspace redesign, average taxi-out time for the affected departures was 13.5 minutes, which fell to 12.0 minutes after the redesign. The standard deviation of taxi-out times fell from 7.7 minutes to 5.8 minutes. The decreased variability and increased predictability in taxi-out times will allow airlines serving PHX to plan more effectively.

6.2.3 Chicago Terminal Airspace Project

The Chicago Terminal Airspace Project (CTAP) is an outgrowth of efforts that began 10 years ago to efficiently service aircraft demand within the Great Lakes region. In 1988, the FAA conducted a Chicago system safety and efficiency review because of concerns over operational errors, continued regional growth, and increased delays to the users. In 1989, the Chicago delay taskforce was established to identify initiatives to enhance safety, improve efficiency, and reduce controller workload. In 1991, the FAA initiated a three-phase program of airspace improvements in the Chicago metropolitan area. Phase II CTAP includes proposed modification of the existing airspace design and procedures, quantification of user benefits, and preparation of an environmental impact statement.

The basic structure of the Chicago regional airspace has not changed in over 20 years, but the number, performance, and mix of aircraft using the airspace has changed. The existing airspace limits flexibility for controllers operating in an extremely complex environment. For aircraft destined to the region, en route in-trail spacing is conservative to avoid saturation of arrival streams. Arriving aircraft are sequenced into a single stream at each cornerpost. En route and terminal arrival spacing and sequencing are achieved through ground holds, speed control, and delay vectors (S-Turns).

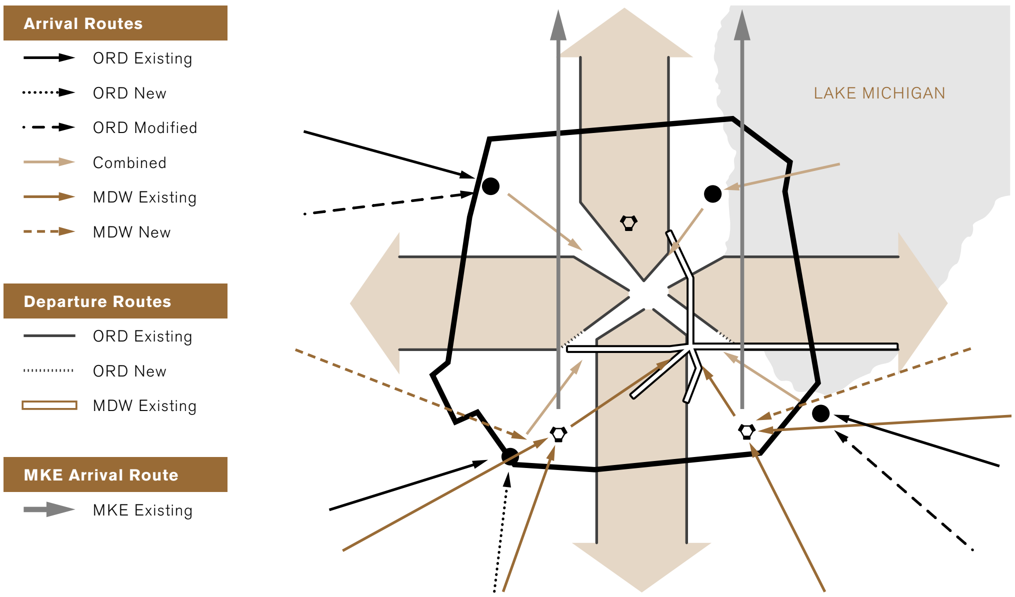
The CTAP modifications are proposed within the existing Chicago ARTCC and Chicago TRACON airspace along the existing high-altitude arrival gateways. Components of the CTAP proposal include:

- One additional high-altitude arrival route, two modified arrival routes, and more flexible use of existing departure corridors for Chicago O'Hare International Airport
- A more direct route for aircraft arriving from the northwest and northeast destined for Chicago Midway Airport, Chicago Meigs Airport, Gary Airport, and other general aviation/reliever airports

The expected benefits of the proposed CTAP modifications include:

- Enhanced safety by reducing complexity of arrival procedures
- Improved on-time service for the flying public
- Fewer miles flown en route are offering potential fuel savings
- Reduced ground-hold delays
- More flexible use of existing departure corridors
- Redundant back-up during radar outages

Figure 6-7: Proposed CTAP Airspace Modifications



6.3 Area Navigation Route Development

Area Navigation (RNAV) refers to any instrument navigation performed outside of the conventional routes defined by the position of ground-based navigational aids or by intersections formed by two navigational aids. Technologies such as Flight Management Systems, LORAN-C, and inertial guidance systems have offered RNAV capability to aircraft for nearly two decades. With the introduction of GPS to civilian aviation in the 1990s, even more aircraft are acquiring RNAV capability.

Aircraft with RNAV equipment can navigate, point-to-point, eliminating the dog-legs that result from using ground-based navigational aids. The FAA is developing RNAV routes in a number of projects focused on the transition from the current ground-based navigational system to a satellite-based system. Two of these projects are described below.

6.3.1 Atlantic High Class A RNAV Routes

The Atlantic High Class A RNAV route project (formerly the Caribbean RNAV route project) was conceived in 1995 by the Miami ARTCC and the Southern Region as an alternate means of handling air traffic in U.S. offshore Class A airspace between Florida and Puerto Rico. Air traffic has been increasing in this region at approximately eight percent per year, but the lack of ground-based navigational aids and limited radar surveillance has substantially restricted airspace capacity. The objective of the Atlantic project is to develop an RNAV route system to supplement the current airway system and to increase capacity by reducing spacing requirements.

Phase 1 was initiated in October 1997 with the implementation of 13 advanced RNAV routes. At a May 1998 project status meeting, airline participants reported fuel and time savings from using the RNAV routes. Those airlines and controllers recommended reducing the number of routes to six and realigning them, while agreeing that additional routes would be developed later. The six revised routes (referred to as "T routes") were implemented in December 1998 for use with radar coverage. The routes are eight nautical miles wide, with at least two nautical miles between parallel routes. Unlike routes based on

VORs (VHF Omni-Directional Range), which widen at distances exceeding 51 nautical miles from the VOR because of the degradation of the signal, the RNAV routes maintain a constant width. This improved signal propagation increases available airspace capacity.

Phase 2, which extended the authorized use of the RNAV routes to times of radar outages, began in late 1999. Nine airlines are participating in this RNAV route project and seven more are expected to participate when their aircraft are properly equipped and their crews are trained.

6.3.2 RNAV Routes in the Northeast

In a collaborative effort among Atlantic Coast Airlines, the Regional Airline Association, and the FAA, 96 RNAV routes were developed for cities served by Atlantic Coast Airlines' turbo-prop aircraft, located in five regions, with routes crossing seven ARTCCs' airspace. The routes were phased in gradually from December 1998 through September 1999.

The benefits of RNAV routes to the airline include increased accuracy in scheduling, reduced "block-to-block" time, and the ability to continue operations in the event of a navigational aid outage. Atlantic Coast Airlines' analysis estimated the distance saved as the result of eliminating the dog-legs associated with VOR-based navigation to be four percent per route. Based on these promising results, the FAA plans to expand the use of RNAV routes to other air carriers and other airports in the Northeast.

6.3.3 Southern Region RNAV Routes

A multiple-ARTCC study is underway in the FAA's Southern Region, with the objective of creating RNAV routes between Atlanta, the central-Florida complex of airports (Tampa, Orlando, Daytona Beach, and Jacksonville), and Miami. Airspace in the Miami, Jacksonville, and Atlanta ARTCC airspace is being redesigned for use by aircraft equipped with advanced navigation systems. Ultimately, user-preferred routes will connect departure runway ends to the arrival runways via transition waypoints. In effect, RNAV departure/arrival corridors will be created to integrate aircraft to and from en route airspace.

In September 1998, departure and arrival transition waypoints were established for Atlanta, Daytona Beach, Jacksonville, Orlando, Tampa, and Miami terminal areas, and en route waypoints were established for Jacksonville Center. In September 1999, the en route portion of the RNAV routes was modeled to determine potential controller workload and possible sector redesign. The analysis found that the present sectorization is adequate for the successful implementation of this project. Full implementation is scheduled for January 2001.

6.3.4 VFR Waypoints for GA Pilots

For many GA pilots, VFR navigation near military special use airspace or other controlled airspace can be difficult because of the lack of visual reference points. To facilitate operations around restricted airspace, the FAA is working with the Aircraft Owners and Pilots Association to establish VFR waypoints.

VFR waypoints will correspond to specific ground features on aeronautical charts and are identified by unique five-letter designators beginning with "VV." Waypoints intended for use during a given flight can be entered into the navigation receiver in sequence prior to departure. Once the waypoints are entered into the receiver database, the GPS or other RNAV system can be used to supplement visual navigation using these waypoint identifiers. VFR waypoints were implemented in the Los Angeles and San Diego areas in July 1999.

6.4 Commercial Space Transportation

The FAA, through the Associate Administrator for Commercial Space Transportation (AST), regulates the U.S. commercial space transportation industry, licenses launches and launch sites, and manages the airspace to ensure safety. Most commercial space launches contain communications, scientific, weather, or remote-sensing satellites and launches are financed by private corporations, the Air Force, and NASA. The majority of commercial space launches occur from Federal launch sites where the Department of Defense owns the infrastructure. Unlike airports, where the FAA builds and maintains air traffic control facilities, the FAA has no infrastructure at launch sites. From 1989, when the first launch was conducted, through September 1999, 119 FAA-licensed launches have taken place.

The number of commercial space launches has been growing rapidly. During 1998, U.S. launch service providers conducted 22 licensed launches, an increase of 29 percent over 1997 and more than four times the number of launches conducted as recently as five years ago. For 1999, 25 licensed launches are already scheduled, a 14 percent increase over 1998 activity. By 2006, the number of U.S. commercial space launches could reach 60 per year, or more than one per week.

In the U.S., there are four FAA licensed launch sites. They are: 1) the Spaceport Florida Authority, 2) the California Spaceport Authority, 3) the Virginia Space Flight Center, and 4) the Alaska Aerospace Development Corporation. Boeing Sea Launch, a sea-based, floating platform financed by a Boeing-led international consortium, is also a platform that commercially operated under the authority of an AST-issued launch operators license held by Boeing. Other possible sites for commercial launches include locations in New Mexico and Texas. Launches from inland launch sites could have significant impacts on aviation traffic flows.

In the past, commercial space launches have had little impact on NAS efficiency because of the infrequency of their occurrence and because most launches have occurred within restricted military airspace. However, as the number of launches and launch facilities increase, the FAA will be increasingly challenged to accommodate the operational needs of all NAS users and mitigate the impacts on aviation traffic caused by launches occurring in restricted airspace. Also, new technology is being introduced by the commercial space transportation industry. Reusable Launch Vehicles (RLV) are now being developed that may take off and re-enter under power on conventional runways, potentially at great speeds. A test launch of a RLV technology demonstrator (NASA's X-33) is scheduled to occur perhaps as early as 2001.

To help meet the challenge of integrating new and additional commercial space operations into the NAS, the FAA's Office of the Associate Administrator for Commercial Space Transportation has developed a concept of operations document that describes commercial space launch operations in the NAS in 2005 and beyond. The space transportation concept of operations document is intended to provide information and guidance that will be useful in the Agency's investment decision making process for new and enhanced NAS capabilities.

CHAPTER 7: NEW OPERATIONAL PROCEDURES

7 New Operational Procedures

New air traffic control procedures can increase capacity with little or no investment in airport infrastructure or equipment. They do this by giving pilots more flexibility in determining their routes, altitude, speed, and departure and landing times. This process is driven by NAS Modernization, for the FAA must develop new procedures that can take advantage of its new technology.

The procedures described in this chapter are grouped by operating environment: en route, oceanic, and terminal/approach. The final section discusses changes in the use of air traffic restrictions that affect all the operating environments.

7.1 En Route Procedures

The North American Route Program, the Three-Dimension User Preferred Trajectories project, and cooperation between the FAA and DOD to increase civilian access to special use airspace are examples of initiatives that will improve pilots' ability to plan and fly direct routes.

7.1.1 The North American Route Program

The North American Route Program (NRP), formerly the National Route Program, gives airlines and pilots increased flexibility in choosing their routes. Aircraft operating under the NRP are not subject to route restrictions such as published preferred IFR routes, letter of agreement requirements, and standard operating procedures. They are only subject to route limitations within a 200 nautical mile radius of take-off or landing. This flexibility allows airlines to fly the most cost-effective routes. NRP operations are authorized at or above FL290 across the contiguous United States and into Canada at specified entry points.

The FAA accommodates all flights that want to take advantage of the NRP. Approximately 1,200 flights per day participated in the NRP during 1997. By 1998, the daily average had increased to more than 2,000 flights. In mid-1999, Cleveland ARTCC reported that it was handling 700 NRP flights per day. Other centers also reported heavy usage.

The FAA has begun to reduce the 200 nautical mile radius exclusion zones by developing DP/NRP/STAR procedures.[12] By July 1999, 26 DPs with 62 associated transitions to the NRP, and 53 STARs with 132 transitions had been implemented in more than 20 airport areas.[13] DPs and STARs for 20 additional airport areas will be evaluated in the next phase of the program. The availability of DP/STAR transitions provide pilots with routing flexibility as they enter and exit the NRP area. In addition, pilots are increasingly filing their flight plans close to flight time, because the route flexibility made possible by the NRP allows them to take advantage of the winds aloft.

The popularity of the NRP has caused some problems with en route congestion at high altitudes. While it has provided pilots with increased flexibility, increasing numbers of NRP flights have overloaded some en route sectors causing controllers to impose miles-in-trail restrictions.

12 These permit a pilot to enter the National American Route Program area using a departure procedure (DP) and exit using a standard terminal arrival route (STAR).

13 The cities include: Denver, Salt Lake City, Minneapolis, Albuquerque, Seattle, Portland, Kansas City, St. Louis, Dallas/Ft. Worth, Houston, San Antonio, Austin, Atlanta, Nashville, and Memphis.

A new procedure, Low Altitude Alternate Departure Route (LAADR), has been implemented to relieve congestion in high altitude sectors in the New York area. This procedure involves capping aircraft at lower altitudes, typically at FL220 or below, to reduce peak congestion, and then stepping them up progressively to higher altitudes. The Command Center analyzes departure volume and expected volume in high altitude sectors and initiates LAADR procedures, if necessary. When the LAADR procedure is in effect, airlines have the option of filing for their preferred altitude, which will entail a departure delay, or accepting a lower altitude initially and being able to enter the NRP area when space is available. As a result of the success of this procedure in reducing high-altitude congestion in the New York area, the FAA will make it available nationally.

7.1.2 Three-Dimension User Preferred Trajectories Flight Trials Project

From February to November 1998, the FAA and five air carriers took part in the Three-Dimension User-Preferred Trajectories Flight Trials (3D UPT). The purpose of the flight trials was to assess the economic benefits of unrestricted flight and the operational changes that would be necessary. After reaching an initial cruise altitude, participating pilots were free to fly at optimal altitudes, based on favorable winds and aircraft performance information. The 3D UPT project differs from the NRP in that it includes priority initial departure, unrestricted climb to cruise altitude, and priority descent. Approximately 30 3D UPT flights took place each day during periods of low traffic between three departure airports (Seattle, San Francisco, and Los Angeles) and arrival airports in the mid-west and east.

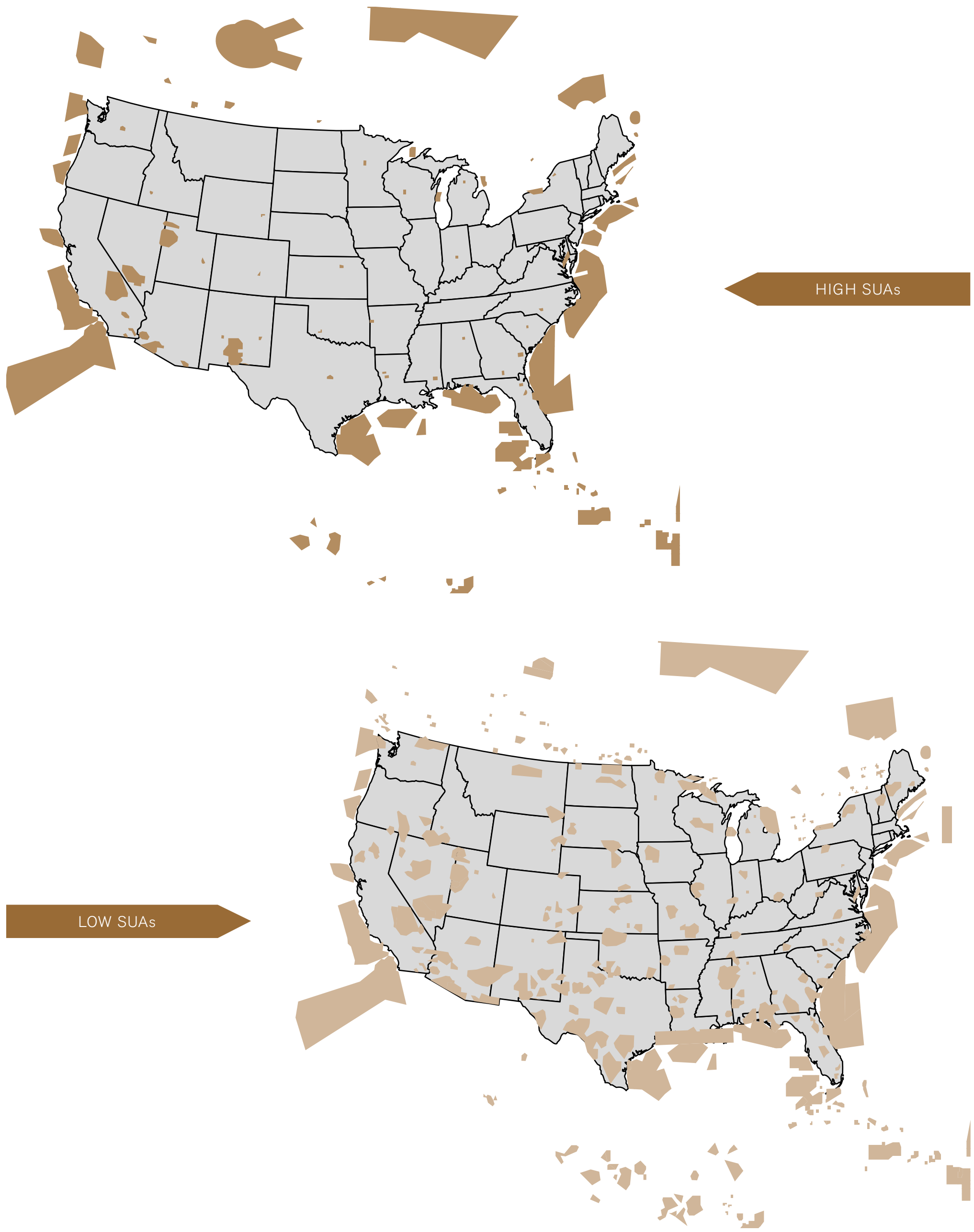
The results of the flight trials have not yet been released, but preliminary findings indicate that the flight time and fuel savings were not as significant as had been anticipated. FAA analysts attributed this shortfall to the inability of the airline flight planning software to file true user-preferred trajectories. Ironically, because the airline flight planning software had been designed at a time when the FAA was operating under more stringent procedures, it could not optimize trajectories in a less restrictive environment. Formal flight trial results will be available in early 2000.

7.1.3 Increasing Civilian Access to Special Use Airspace

Special use airspace (SUA) is reserved for military use unless authorization for civilian use is granted by the military. SUA covers large portions of the United States and civilian aircraft operations are often constrained by SUA-imposed restrictions.

For example, Cincinnati Airport's airspace is restricted by a military operations area (MOA) 35 miles east of the airport and a parachute jump area to the northeast. If arrivals from the northeast are required to hold in the air, the only airspace available for the holding pattern is that between the arrival route and the MOA, which is normally used by eastbound departures. When this occurs, at least some eastbound departures must be held on the ground, increasing departure delays and airport surface congestion. Figure 7-1 depicts the extent of SUA.

Figure 7-1: Special Use Airspace



The FAA is working with the DOD and NAS users to develop new systems and procedures that will permit greater civilian access to SUA. For these procedures to be effective, real-time information on SUA status must be available. The Special Use Airspace Management System (SAMS) was fielded by the FAA in late 1997. The central servers located at the Command Center are the FAA's depository of SUA information. In the near future, the aviation community will be able to access this information via a secure gateway. A corresponding system, the Military Airspace Management System (MAMS), will interface with SAMS, allowing the military to electronically transfer SUA information to the FAA. These two systems will provide better information which will improve the management of SUA.

FAA facilities are also working with the military to improve the use of SUA. For example, Jacksonville, which has more SUA than any other ARTCC east of the Mississippi, is collaborating with the military to maximize safe civil aircraft transit through offshore warning areas.

7.2 Oceanic En Route Procedures

Limitations in communications and surveillance over the ocean have necessitated horizontal separation minima of 60 to 100 nautical miles laterally, 15 minutes longitudinally and 2,000 feet vertical separation. These large separation minima limit the ability of controllers to grant preferred routes or altitudes during peak traffic periods. Oceanic separation minima are being incrementally reduced as a result of improved navigational capabilities made possible by highly accurate altimeters, advanced navigation, and satellite communications.

7.2.1 Reduced Vertical Separation Minima

The goal of Reduced Vertical Separation Minima (RVSM) is to reduce the oceanic vertical separation between FL290 and FL410 from the current 2,000 feet minimum to 1,000 feet. RVSM improves system efficiency by increasing the number of available altitudes, allowing aircraft to operate closer to optimal altitudes. Fuel savings from aircraft flying more efficient routes are projected to range from 13 to 18 million gallons annually. Operational trials of RVSM began in North Atlantic airspace from FL330 to FL370 in March 1997. The trials have shown that fewer flight tracks are required as users take advantage of the available flight levels on prime tracks. The application of RVSM was expanded in October 1998 from FL310 to FL390. Full implementation for FL290 to FL410 should be complete by 2001.

Based on the successful implementation of RVSM in the North Atlantic, NAS users have requested RVSM in the Pacific. The International Civil Aviation Organization (ICAO) responded by forming a task force, which is led by FAA experts. The task force plans to implement RVSM in Pacific airspace by February 2000. For U.S. commercial carriers alone, annual fuel savings are estimated to exceed $12 million.

7.2.2 Reduced Horizontal Separation Minima

In April 1998, oceanic lateral separation standards in the Northern Pacific Route System were reduced from 100 to 50 nautical miles. Lateral separation was also reduced to 50 nautical miles in the Central Pacific in December 1998. The FAA plans to implement 50 nautical mile lateral separation in the Central East Pacific in February 2000.

7.3 Terminal Area/Approach Procedures

Due to the complex nature of operations in the terminal area, the FAA specifies the speed, decision heights, and other aspects of operations as aircraft depart and approach the terminal area. The FAA is working on ways to increase airport traffic flow by modifying approach and other procedures, some of which are discussed below.

Although the FAA is aggressively developing strategies to increase capacity, safety always takes precedence. An example of this deliberate approach is found in the last part of this section, which describes modifications in the usage criteria for Land and Hold Short Operations to add an extra margin of safety.

7.3.1 Area Navigation Arrival and Departure Procedures

Area navigation is often restricted by air traffic control procedures that are based on established route structures. In high-density terminal airspace, where air traffic controllers rely on departure procedures (DP) and standard terminal arrival routes (STAR) to align and sequence traffic, it is difficult for them to accommodate non-standard RNAV arrival and departure procedures at the same time. For this reason, the use of RNAV arrival and departure routes are generally limited to periods of low traffic.

To make greater use of RNAV in terminal airspace, the FAA has begun to develop RNAV arrival and departure procedures for the top 50 airports. Five airports already have published RNAV procedures: Seattle-Tacoma, Milwaukee, Boston, and Houston (George Bush), and Los Angeles International.

A new RNAV departure procedure at LAX, which became effective in January 1999, allows aircraft departing to the west to fly a more precise departure course. Previously, aircraft frequently crossed the airport boundary before the shoreline, exposing communities to the north and south of the airport to noise. Approximately 65 percent of the jet departures from LAX are able to use the new procedure. The FAA plans to develop a similar RNAV procedure for turboprop aircraft, which should further decrease the impact on the neighborhoods surrounding the airport.

For major airports within 500 nautical miles of each other (such as Phoenix and: Las Vegas, Salt Lake City, and Los Angeles), the FAA is exploring the concept of city pair DP/STAR routes. The STAR would begin where the DP ends, so that en route air traffic control would not be required.

7.3.2 Removal of 250-Knot Speed Limit

Aircraft are currently restricted to a speed of 250 knots below 10,000 feet mean sea level. This restriction can constrain capacity by limiting departure rates from busy terminal areas. In June 1997, the FAA began a field test of the impact of removing the 250-knot speed limit for departures from Houston Class B airspace. The results of the test were generally positive. The majority of pilots and controllers who were interviewed supported the concept, and many controllers did remove the speed limit when authorized to do so. The surrounding communities perceived no noise impact from removing the speed limit.

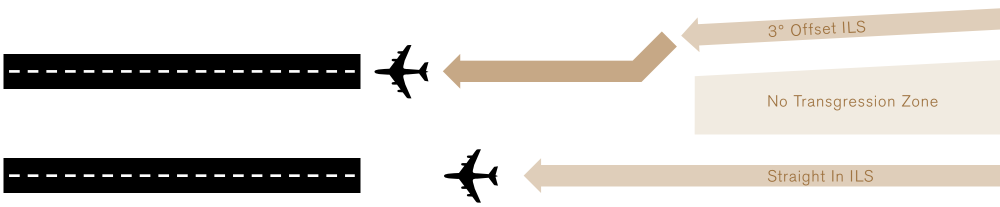
One concern raised by the test was an apparent increase in the number of aircraft exiting Class B airspace below 10,000 feet at speeds greater than 250 knots. Pilots may have traded altitude for speed during the test and tended to exit Class B airspace at lower altitudes, possibly posing a hazard to aircraft in the surrounding airspace. A safety analysis was initiated in July 1999 to see if these issues can be resolved and then extend the program to other airports.

7.3.3 Simultaneous Offset Instrument Approaches

A combination of technology and procedures called Simultaneous Offset Instrument Approaches (SOIA) is being developed. This combination can increase capacity at airports with closely spaced parallel runways. Using a Precision Runway Monitor, an offset ILS localizer and glide slope, and a new procedure, SOIA may be able to reduce the minima for simultaneous approaches to parallel runways with centerlines as little as 700 feet apart. For example, SOIA could be used at San Francisco International which has just such close parallel runways, to safely reduce approach minimums from 2,400 to 1,600 feet and to reduce visibility from five to four miles.

In the SOIA procedure, pilots on the offset approach would fly a straight-but-angled instrument (and possibly autopilot) approach until descending below the cloud cover. At that point, they would have a period of time to visually acquire the traffic on the other approach, until they reach the missed approach point (MAP). If, as expected, the pilots visually acquire the traffic on the other approach before the aircraft reaches the MAP, they would continue the approach to the runway. An analysis of the use of SOIA procedures is underway. Other potential sites for SOIA include St. Louis and Newark airports.

Figure 7-2: Simultaneous Offset Instrument Approach



7.3.4 Restrictions on Land and Hold Short Operations

Simultaneous Operations on Intersecting Runways (SOIR) have been used as a tool by air traffic controllers to increase airport capacity since 1968. On April 11, 1997, the FAA expanded and replaced SOIR with Land and Hold Short Operations (LAHSO). LAHSO, like SOIR, is an air traffic control tool used to enhance airport capacity. LAHSO includes landing and holding short of an intersecting runway, taxiway, approach/departure flight path, or predetermined point on the runway.

In February 1999, the FAA, in coordination with the Air Transport Association and the Air Line Pilots Association, International, made a number of changes in procedures for conducting LAHSO to address pilot concerns. These changes became effective on April 15, 1999. As of this date, air carriers participating in LAHSO are required to be authorized to operate specific aircraft types to specific runways. Additional limitations include that LAHSO may be conducted on dry runways as it is prohibited on wet runways. Weather conditions for air carrier operations may be lowered to a ceiling of no less than 1,000 feet and a visibility of no less than three statute miles where a Precision Approach Path Indicator or Visual Approach Slope Indicator is installed and operational. LAHSO is not authorized or may not be conducted if windshear has been reported within the previous 20 minutes prior to the LAHSO clearance being issued or to any runway where a tailwind exists or does not have visual vertical guidance.

7.4 Air Traffic Restrictions

Air traffic restrictions are used by controllers to manage their workload, avoid congestion, and restrict aircraft movement during periods of severe weather. For example, during high volume arrival and departure periods, air traffic controllers may request that arriving aircraft maintain 10 miles-in-trail separation from the preceding aircraft to moderate traffic flow into the terminal area. Other types of restrictions include arrival sequencing, altitude restrictions, airborne holding, and ground stops.

Restrictions can be dynamic or tactical. Dynamic restrictions are intended to capture traffic due to an event such as a storm system or high volume. They are applied for a set period of time, with a maximum of two hours, but can be extended. Tactical restrictions are applied for one hour or less, and are only applied to specific aircraft. With increasing traffic, especially at high-altitudes where regional jets are increasingly using the same altitudes as commercial jets, the need to impose restrictions is also increasing. At low altitudes, where traffic has not been growing as quickly, there has been no corresponding increase in the need for restrictions.

Requests for restrictions are coordinated through the Command Center, which analyzes options from a national perspective. Local facilities must consider all other options before calling the Command Center to request a restriction. The decision to impose the restriction requires consensus between the Command Center and the requesting facility. These safeguards minimize the use of restrictions.

In response to airline concerns about the increasing number of flight delays, the FAA is giving increased emphasis to managing restrictions. For example, the Command Center is analyzing known system choke-points to determine how traffic patterns or the use of restrictions can be modified to achieve daily improvements in traffic flow. The Command Center is also collecting data on experience with miles-in-trail restrictions for the purpose of developing better criteria for their use. In addition, the Command Center will have a representative at major air traffic facilities to coordinate decision making.